

Subsurface Investigation Report of Findings

**Former Rio Dell Texaco
Case No. 12691**

Prepared for:

Dorothy Bianchi



Consulting Engineers & Geologists, Inc.

812 W. Wabash
Eureka, CA 95501-2138
707/441-8855

March 2006
004323



CONSULTING ENGINEERS & GEOLOGISTS, INC.

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Reference: 004323

March 30, 2006

Mr. Mark Verhey
Humboldt County Division of Environmental Health
100 H Street, Suite 100
Eureka, CA 95501

Subject: Subsurface Investigation Report of Findings, Former Rio Dell Texaco, 100 Wildwood Avenue, Rio Dell, California; Case No. 12691

Dear Mr. Verhey:

The attached report presents the results of the Subsurface Investigation performed at the Former Rio Dell Texaco site. Also included are the results of the chemical oxidation treatability study.

Please do not hesitate to call me if you have any questions.

Sincerely,

SHN Consulting Engineers & Geologists, Inc.

A handwritten signature in black ink, appearing to read "Frans Lowman".

Frans Lowman, P.G.
Project Manager
441-8855

FBL/RMR:lms

Attachment: Report of Findings
copy w/ attach: Dorothy Bianchi
USTCF

Reference: 004323

Subsurface Investigation Report of Findings

**Former Rio Dell Texaco
Case No. 12691**

Prepared for:

Dorothy Bianchi

Prepared by:



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March 2006

QA/QC:MKF____

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Abbreviations and Acronyms

<	less than		
g/cm ³	grams per cubit centimeter	HCDEH	Humboldt County Division of Environmental Health
gpm	gallons per minute	IP-#	Injection Point-number
mS/m	millSiemens per meter	LACO	LACO Associates
psi	pounds per square inch	MIP	Membrane Interface Probe
ug/L	micrograms per Liter	MTBE	Methyl Tertiary-Butyl Ether
uV	microvolts	MW-#	Monitoring Well-#
		PID	Photoionization Detector
ASTM	American Society for Testing and Materials	PVC	Polyvinyl Chloride
B-#	Boring-#	SC	Soil Conductivity
BGS	Below Ground Surface	SHN	SHN Consulting Engineers & Geologists, Inc.
BTEX	Benzene, Toluene, Ethylbenzene, and total Xylenes	TAME	Tertiary-Amyl Methyl Ether
DIPE	Diisopropyl Ether	TBA	Tertiary-Butyl Alcohol
EPA	(U.S.) Environmental Protection Agency	TPHD	Total Petroleum Hydrocarbons as Diesel
ETBE	Ethyl Tertiary-Butyl Ether	TPHG	Total Petroleum Hydrocarbons as Gasoline
FID	Flame Ionization Detector	USGS	U.S. Geological Survey
		UST	Underground Storage Tank

1.0 Introduction and Background

This report presents the results of the subsurface investigation and a chemical oxidation treatability study conducted by SHN Consulting Engineers & Geologists, Inc. (SHN) for the Former Rio Dell Texaco site. The site is located at 100 Wildwood Avenue, Rio Dell, California (Figure 1).

In December 1990, a 200-gallon waste oil Underground Storage Tank (UST) was removed from the site. Contaminated soils were excavated from the vicinity of the waste oil UST in August 1992. Laboratory analytical results of soil and groundwater samples collected during the overexcavation indicated the presence of petroleum hydrocarbons in soil, but not in groundwater. In November 1996, the Humboldt County Division of Environmental Health (HCDEH) issued a remedial action completion certificate for the waste oil UST (LACO, 1998).

In September and October 1998, Northcoast Environmental Construction removed six USTs from the site. Low concentrations of petroleum hydrocarbons were detected in several soil samples from the excavation cavities (LACO, 1998). In February 2000, LACO Associates (LACO) installed six soil borings (B-1 through B-6) and four monitoring wells (MW-1 through MW-4), and initiated quarterly groundwater monitoring and sampling (LACO, 2000).

In 2001, LACO performed a sensitive receptor survey for a 1,000-foot radius from the site. Two active wells were identified within the search area; one well was reportedly used for irrigation, and the other for domestic use and irrigation. Both wells are located cross gradient of the site (LACO, February 2002).

In March and April 2002, LACO installed eight additional soil borings/temporary well points (B-7 through B-14) at the site (LACO, June 2002).

In January 2004, LACO installed four additional soil borings/temporary well points (B-15 through B-18) at the site (LACO, 2004).

2.0 Objectives

The objectives of this subsurface investigation and chemical oxidation treatability study was to determine the horizontal and vertical extent of the source area soil and groundwater contamination, to perform a chemical oxidation treatability study, and to perform an injection test using water to determine if injection of fluids into the subsurface is feasible at the site.

3.0 Scope of Work

The field program consisted of:

- installing seven Membrane Interface Probe borings (MIPs),
- installing of five soil borings,
- installing of three temporary well points,
- performing slug tests in site monitoring wells,
- performing a chemical oxidation treatability study, and
- performing an injection test using water as a surrogate for chemical oxidation.



SOURCE: SCOTIA AND RIO DELL
USGS 7.5 MINUTE QUADRANGLES

1" = 1,500'

SHW Consulting Engineers & Geologists, Inc.	Former Rio Dell Texaco Rio Dell, California	Site Location Map SHN 004323
	January, 2005	004323-FIG-1

Figure 1

3.1 Field Program

MIP borings, soil borings, temporary well points, and the temporary injection point were installed using a truck-mounted Geoprobe®. Soil and groundwater samples were collected from select borings. Slug tests were performed on select wells. Figure 2 depicts investigation locations and Appendix A presents field notes.

3.2 Membrane Interface Probe Borings

On October 3, 2005, SHN supervised Fisch Drilling in the installation of seven MIP borings. The MIP borings were used to screen the area around the former dispenser area for hydrocarbon contamination and subsurface lithology. The MIP probe consists of a Soil Conductivity (SC) sensor, which measures the electrical conductivity of the soil in milliSiemens per meter (mS/m). In general, low conductivities are indicative of sands, while clays and silts have a higher conductivity. The probe also has a heated block with a permeable membrane. During advancement of the probe, compounds diffuse across the membrane and are carried to onboard detectors by an inert carrier gas. The probe is advanced in 6-inch increments and allowed to rest approximately one minute between each advancement, to allow the carrier gas to transport constituents to the detector. The detectors used during this investigation included a Photoionization Detector (PID) and a Flame Ionization Detector (FID), which are used to detect petroleum hydrocarbons.

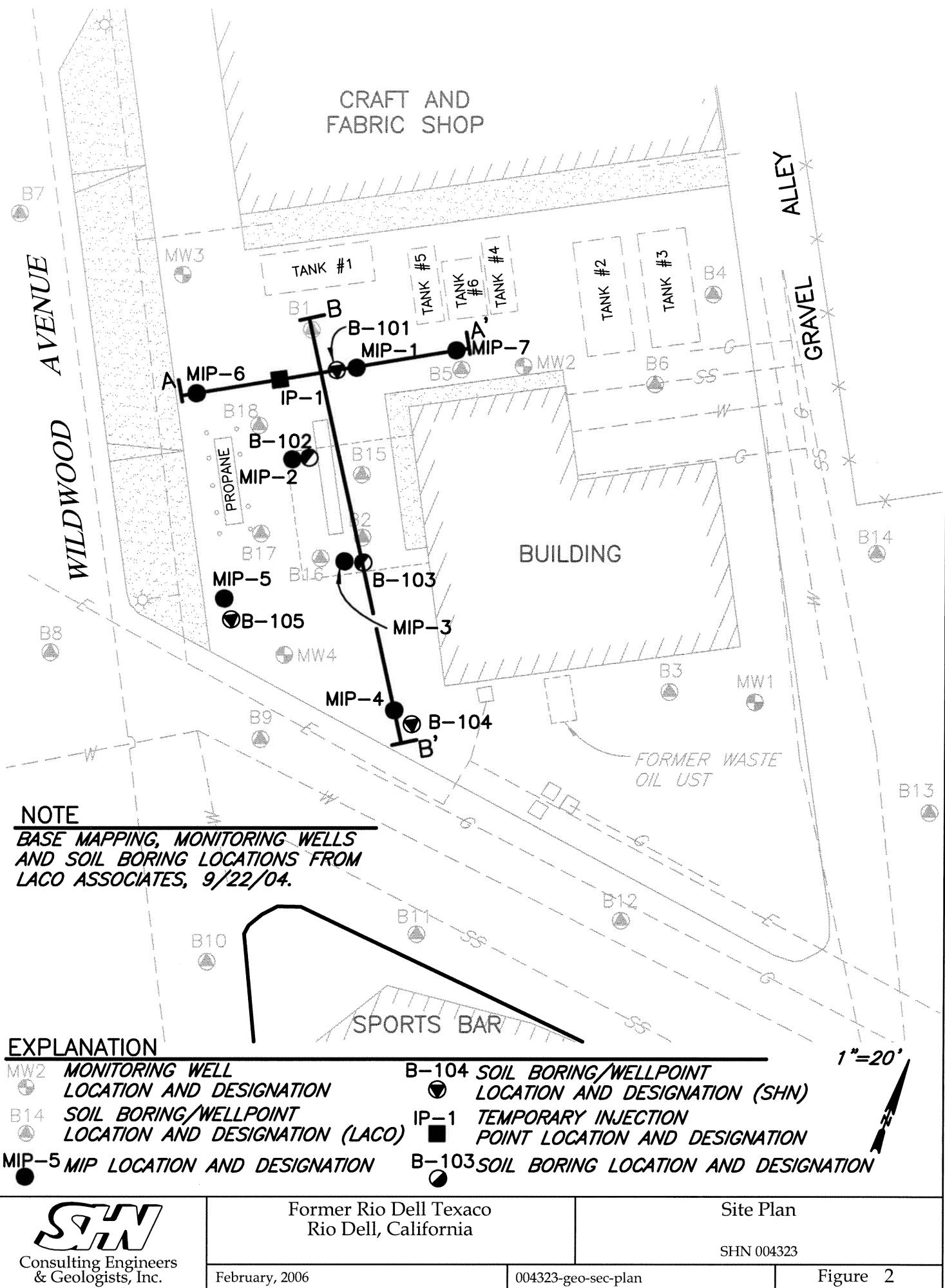
All MIP borings were filled with bentonite chips and capped to match the existing surface upon removal of the MIP equipment. Appendix B includes the MIP logs.

3.3 Soil Borings/Well points

On October 4, 2005, SHN supervised Fisch Drilling in the installation of five soil borings (B-101 through B-105). Borings were advanced using a truck mounted Geoprobe® 6600 equipped with the Geoprobe® Macro-core sampling system. Continuous soil samples were collected in 4-foot intervals to a maximum depth of 20 feet Below Ground Surface (BGS). Following retrieval of the sampler, the plastic tube was removed from the sampler, and the selected sample aliquot was cut from the desired depth and sealed on both ends with Teflon® tape and plastic caps. Soils in the remaining sample tubes were used for soil descriptions. Each soil sample was labeled with the project name, project number, sample number, sample depth, sample time, and date. All samples were placed in Ziploc® bags and stored in an iced cooler. Selected soil samples were submitted to the laboratory for analysis. Each soil sample was analyzed for constituents described in the "Laboratory Analysis" section. Sample handling, transport, and delivery to the laboratory were documented using chain-of-custody procedures.

Six soil samples were submitted for laboratory analysis for petroleum hydrocarbons. Two soil samples were submitted for analysis of physical properties. Two soil samples from B-101 and B-102 (at 6.5 feet BGS) were submitted for the chemical oxidation treatability study. Appendix B includes copies of the soil boring logs.

Three groundwater samples were collected from temporary well points using 1-inch diameter Polyvinyl Chloride (PVC) casing and screen inserted into an open borehole or the Geoprobe® Well Point Screen Sampler. Groundwater was collected from each boring using new polyethylene tubing with a bottom mounted check valve and placed in laboratory supplied containers. Each groundwater sample container was labeled with the project name, project number, sample number, sample time, and date and placed in an iced cooler. Each groundwater sample was analyzed for



constituents described in the "Laboratory Analysis" section. Sample handling, transport, and delivery to the laboratory were documented using chain-of-custody procedures. Three groundwater samples were submitted for petroleum hydrocarbon analysis, and one groundwater sample from B-101 was submitted for the chemical oxidation treatability study.

3.4 Temporary Injection Point

One temporary injection point (IP-1) was installed at the site. The injection point was constructed using 1.5-inch diameter hollow stainless steel rods with a 4-foot long injection tip. The rods were driven to the first injection depth (9-feet BGS), and then retracted, exposing the injection tip from 5 to 9 feet BGS. A Geoprobe® GS-1100 grout pump was used to pump potable water from the municipal water supply into the formation. After injection of approximately 10 gallons of water, the rods were advanced to 14 feet BGS and retracted exposing the injection tip from 10 to 14 feet BGS. Approximately 10 gallons of water were injected at the deeper interval.

3.5 Slug Test

On January 6, 2006, SHN conducted rising head slug tests in monitoring wells MW-1, MW-2, and MW-4. A clean disposable bailer was advanced into each well and the water level was allowed to equilibrate. The bailer was removed and the water level response was measured using a down-hole pressure transducer. The Bower-Rice Method was then used to calculate the hydraulic conductivity.

3.6 Laboratory Analysis

Each soil sample was analyzed for:

- Total Petroleum Hydrocarbons as Diesel (TPHD) in general accordance with U.S. Environmental Protection Agency (EPA) Method Number 8015B; and
- Total Petroleum Hydrocarbons as Gasoline (TPHG), Benzene, Toluene, Ethylbenzene, total Xylenes (BTEX), and fuel oxygenates in general accordance with EPA Method Number 8260B.

Soil samples were submitted to North Coast Laboratories, of Arcata, California.

Additional soil samples were analyzed by Daniel B. Stephens & Associates of Albuquerque New Mexico for:

- Total Organic Carbon in general accordance with the Walkley-Black Method (2 samples);
- moisture content and bulk density in general accordance with American Society for Testing and Materials (ASTM) Methods D 2216 and D 4531, respectively (2 samples); and
- particle size analysis in general accordance with ASTM D422 (1 sample).

Each groundwater sample from the temporary well points was analyzed for:

- TPHD in general accordance with EPA Method Number 8015B.
- TPHG, BTEX, and fuel oxygenates in general accordance with EPA Method Number 8260B.



Groundwater samples were submitted to North Coast Laboratories, of Arcata, California.

3.7 Equipment Decontamination Procedures

All boring equipment was cleaned prior to bringing it on site. All direct push equipment and small equipment that required on-site cleaning was cleaned using the triple wash system. The equipment was first washed in a water solution containing Liquinox® cleaner, followed by a water rinse, then by a distilled water rinse. Soil and groundwater samples were collected in disposable tubes or in pre-cleaned containers supplied by the analytical laboratory.

3.8 Investigation Derived Waste Management

No soil cuttings were generated using the Geoprobe® system.

Water used in the decontamination of equipment, and all well point development purge water was containerized. The water was transported to SHN's purge water storage facility and was discharged, under permit, to the City of Eureka Wastewater collection system. Approximately 5 gallons of water were generated during this investigation. A discharge receipt is included in Appendix A.

4.0 Results of the Investigation

4.1 MIP Borings

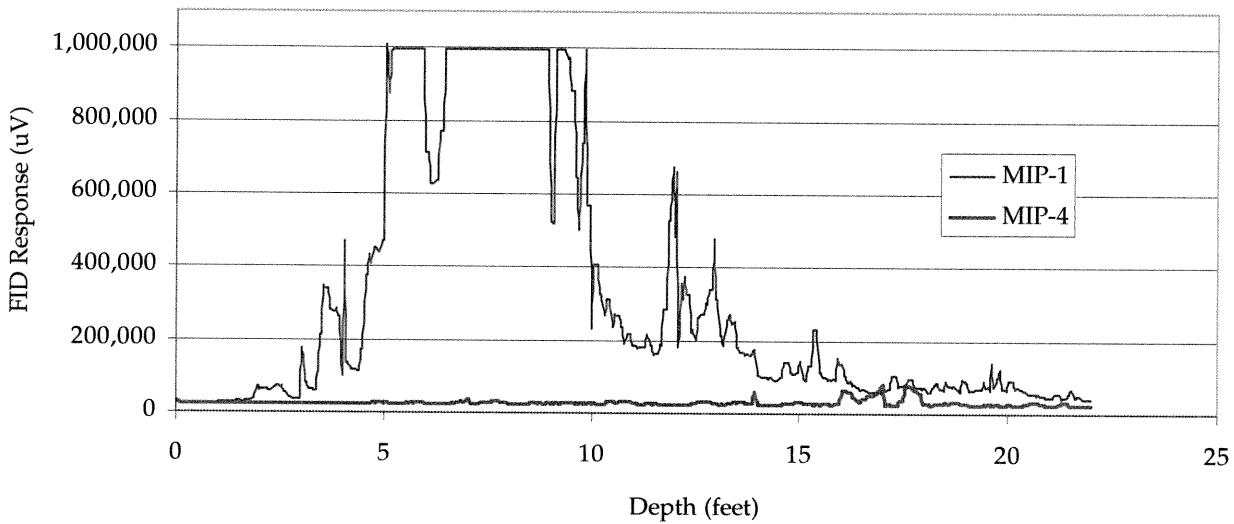
4.1.1 PID and FID Detector Response

The PID and FID detectors report data in microvolts (uV). In general, the higher the response indicates higher concentrations of petroleum hydrocarbons. Figure 3 shows the FID response from MIP-4 (little to no petroleum hydrocarbons) with that from MIP-1 (high levels of petroleum hydrocarbons). Responses from the detectors showed that the highest readings were present between approximately 5 to 10 feet BGS. This indicates that there is minimal vadose zone soil contamination at the site, with the bulk of the contamination within the smear zone and the saturated zone. Cross sections of MIP data are provided as Figures 4 and 5. MIP logs are included in Appendix B.

4.1.2 Soil Conductivity

Soil Conductivity (SC) measurements were used to confirm site lithology. Due to the fine-grained soils at the site, the SC measurements were generally high, as would be expected with fine-grained soils. The interbedded silty sands and silty, sandy gravels were not readily distinguished on the SC logs, and may be due to the abundant fine grained materials or thin nature of these deposits.

Figure 3
MIP Fid Response, MIP-1 and MIP-4
Former Rio Dell Texaco, Rio Dell, California



4.2 Subsurface Lithology

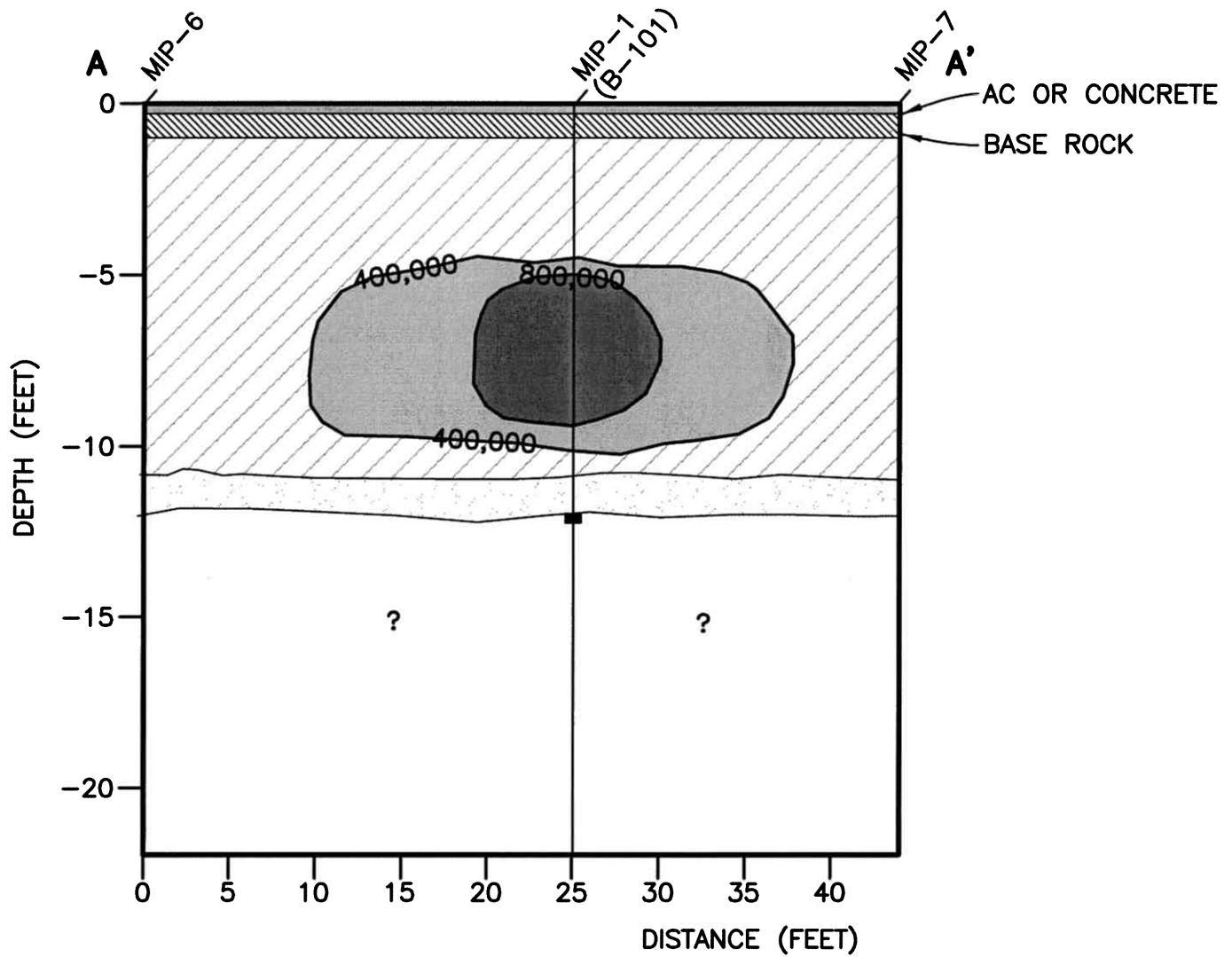
In general, underlying soils consisted of silts and clays with interbedded silty sands and silty, sandy gravels. One sample from B-102 @ 10-11 feet was analyzed for particle size analysis and consisted of approximately 13% fine sand, 70% silt, and 17% clay.

4.3 Subsurface Hydrology

Slug test data was analyzed using spreadsheets compiled by the U.S. Geological Survey (USGS) for the analysis of slug test data (Halford & Kuniansky, 2002). Using the spreadsheets, an average hydraulic conductivity of 4.6 feet per day was calculated for monitoring well MW-1, 0.05 feet per day for well MW-2, and 7.9 feet per day for monitoring well MW-4. Using an average gradient of 0.1 (from the last four quarterly groundwater monitoring events), the average hydraulic conductivity value (4.2 feet per day), and an estimated effective porosity of 25%, a seepage velocity of 1.7 feet per day or 613 feet per year was calculated. Slug test data are included in Appendix C.

4.4 Soil Sampling

Six soil samples were collected for laboratory analysis for petroleum hydrocarbons. Results are presented in Table 1. Two soil samples were tested for physical properties. Laboratory analytical reports are included in Appendix D. A summary of soil analytical results is shown on Figure 6.



SCALE: 1"=10' HORIZ
1"=5' VERT

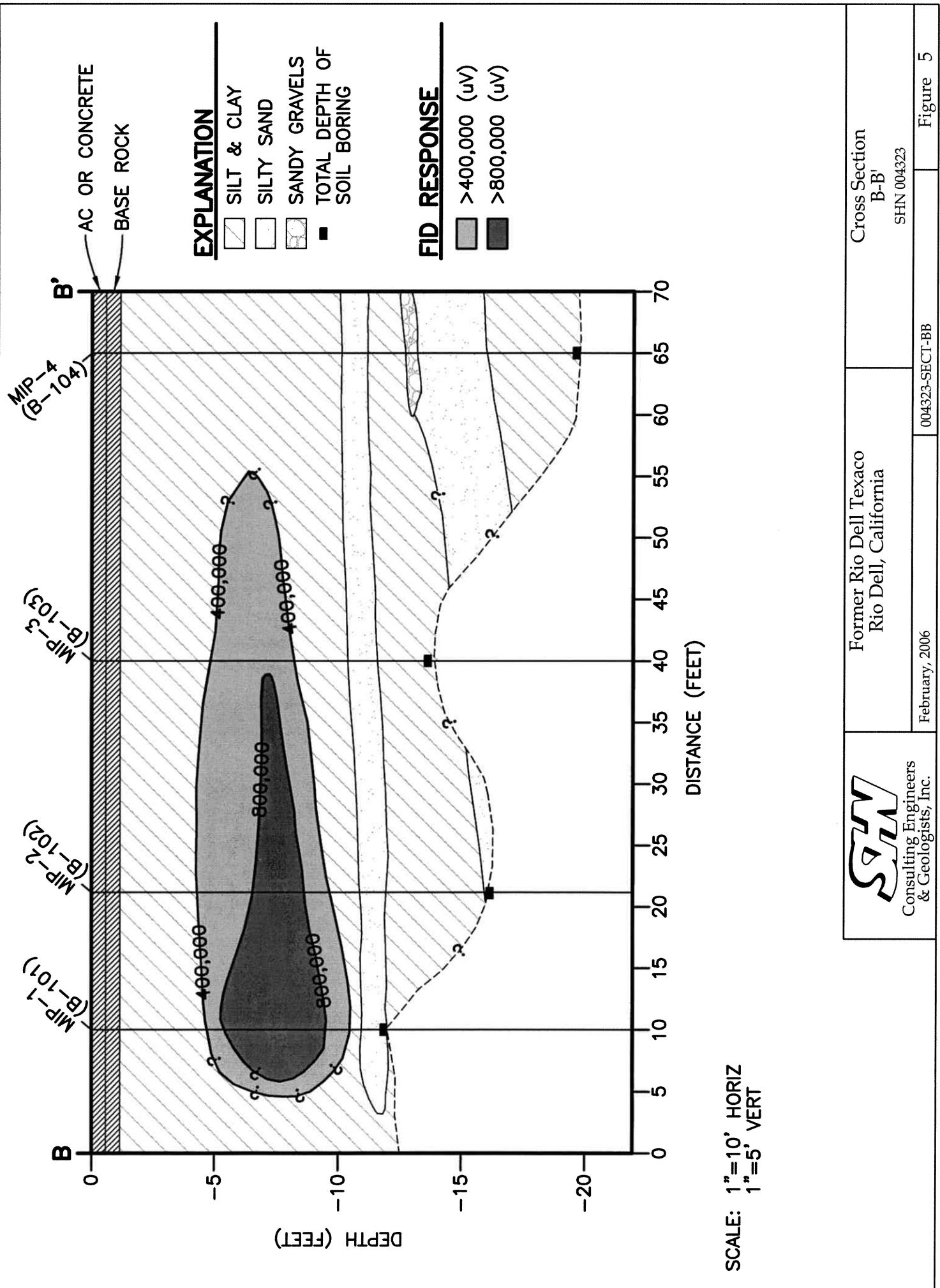
EXPLANATION

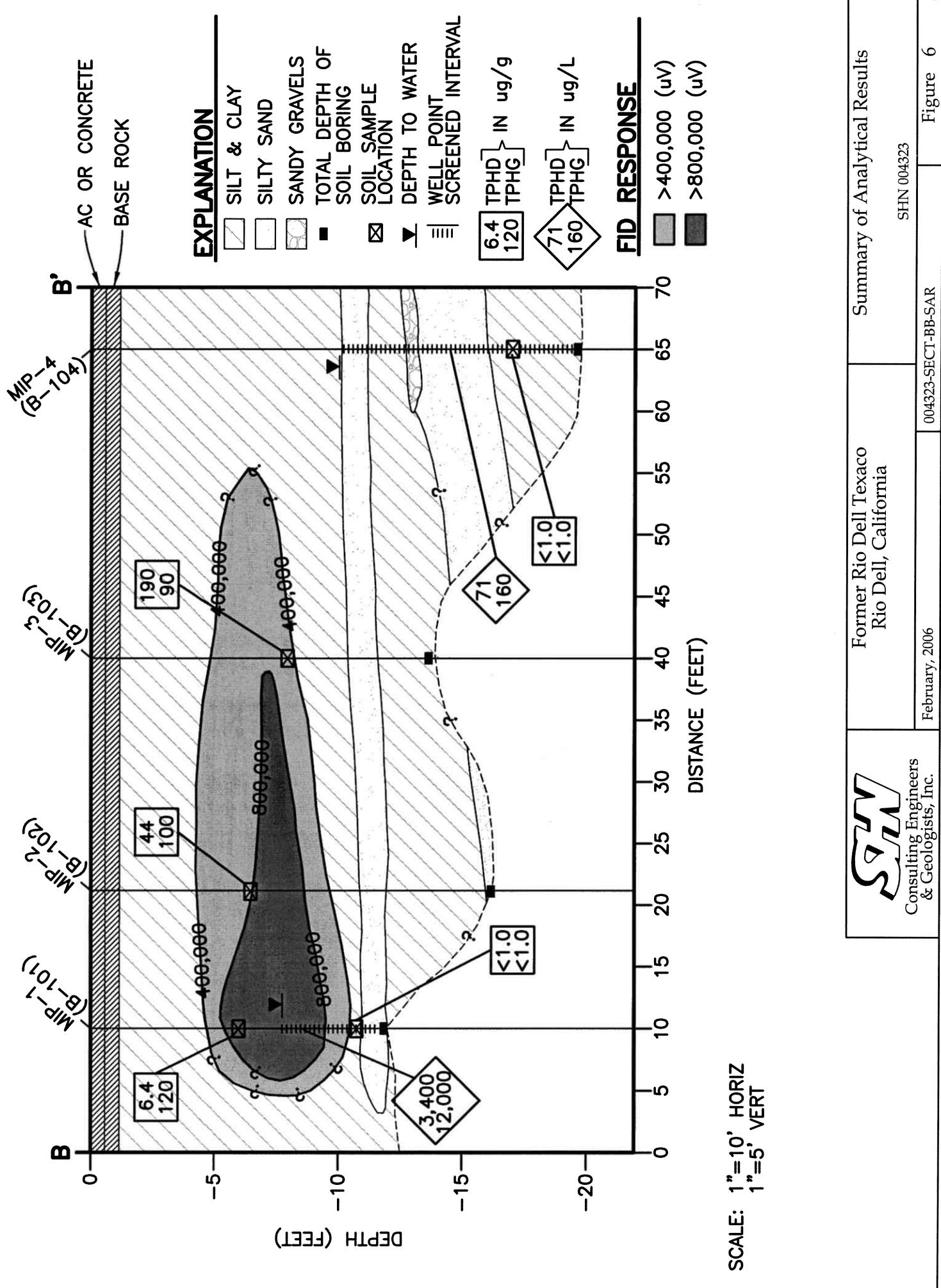
- [Hatched Box] SILT & CLAY
- [White Box] SILTY SAND
- TOTAL DEPTH OF SOIL BORING

FID RESPONSE

- [Light Gray Box] >400,000 (uV)
- [Dark Gray Box] >800,000 (uV)

Cross Section
A-A'
SHN 004323





SCALE: 1"=10' HORIZ
1"=5' VERT



Former Rio Dell Texaco
Rio Dell, California

Summary of Analytical Results

SHN 004323

Figure 6

February, 2006

004323-SECT-BB-SAR

Table 1
Soil Analytical Results, October 4, 2005
Former Rio Dell Texaco, Rio Dell, California
(in ug/g)¹

Sample Location/Depth (feet)	TPHD ²	TPHG ³	B ³	T ³	E ³	X ³	MTBE ³	TBA ³	DIPE ³	ETBE ³	TAME ³
B-101 @ 6'	6.4^{4,5}	120⁶	0.0058	0.012	0.13	0.031	<0.025 ⁷	<0.50	<0.020	<0.020	<0.020
B-101 @ 11.5'	<1.0	<1.0	<0.0050	<0.0050	<0.0050	<0.010	0.027	<0.50	<0.020	<0.020	<0.020
B-102 @ 6.5'	44^{4,8}	100⁹	0.038	0.015	1.2	0.1697	<0.085	<0.50	<0.020	<0.020	<0.020
B-103 @ 7.5'	190^{4,8}	90⁹	<0.0050	<0.013	0.14	<0.020	<0.067	<0.50	<0.020	<0.020	<0.020
B-104 @ 16.5	<1.0	<1.0	<0.0050	<0.0050	<0.0050	<0.010	<0.025	<0.50	<0.020	<0.020	<0.020
B-105 @ 15'	<1.0	<1.0	<0.0050	<0.0050	<0.0050	<0.010	<0.025	<0.50	<0.020	<0.020	<0.020

1. ug/g: micrograms per gram.
2. Total Petroleum Hydrocarbons as Diesel (TPHD) analyzed in general accordance with United States Environmental Protection Agency (EPA) Method Number 8015B.
3. Total Petroleum Hydrocarbons as Gasoline (TPHG), Benzene (B), Toluene (T), Ethylbenzene (E), total Xylenes (X), Methyl Tertiary-Butyl Ether (MTBE), Tertiary-Butyl Alcohol (TBA), Diisopropyl Ether (DIPE), Ethyl Tertiary-Butyl Ether (ETBE), and Tertiary-Amyl Methyl Ether (TAME) analyzed in general accordance with EPA Method Number 8260B.
4. Contains some material lighter than diesel; however, some of this material extends into the diesel range of molecular weights.
5. Contains material in the diesel range of molecular weights, but the material does not exhibit the peak pattern typical of diesel oil.
6. Does not present a peak pattern consistent with that of gasoline. The reported result represents the amount of material in the gasoline range.
7. <: Denotes a value that is "less than" the method detection limit.
8. Contains material similar to degraded or weathered diesel oil.
9. Appears to be similar to gasoline, but certain peak ratios are not that of a fresh gasoline standard. The reported results represent the amount of material in the gasoline range.

Table 2
Soil Physical Properties Results, October 4, 2005
Former Rio Dell Texaco, Rio Dell, California

Sample Location / Depth (feet)	Dry Bulk Density (g/cm ³) ¹	Wet Bulk Density (g/cm ³)	Calculated Porosity (%)	Fraction Organic Carbon (%)
B-102 @ 10-11'	1.66	2.03	37.2	0.18
B-103 @ 11.5'	1.79	2.06	32.4	0.20

1. g/cm³: grams per cubic centimeter

4.5 Groundwater Sampling

Groundwater was sampled from temporary well points installed in borings B-101, B-104, and B-105. Results are shown in Table 3. Laboratory analytical reports are included in Appendix C.

Table 3
Groundwater Analytical Results, October 4, 2005
Former Rio Dell Texaco, Rio Dell, California
(in ug/L)¹

Sample Location	TPHD ²	TPHG ³	B ³	T ³	E ³	X ³	MTBE ³	TBA ³	DIPE ³	ETBE ³	TAME ³
B-101	3,400 ^{4,5}	12,000 ⁶	20	22	360	178.6	<500 ⁷	<10	<1.0	<1.0	11
B-104	71 ⁵	160 ⁸	<0.50	<0.50	<0.50	<0.50	120	<10	<1.0	<1.0	4.8
B-105	<50	150 ⁸	<0.50	<0.50	<0.50	<0.50	97	<10	<1.0	<1.0	<1.0

1. ug/L: micrograms per Liter.
2. Total Petroleum Hydrocarbons as Diesel (TPHD) analyzed in general accordance with United States Environmental Protection Agency (EPA) Method Number 8015B.
3. Total Petroleum Hydrocarbons as Gasoline (TPHG), Benzene (B), Toluene (T), Ethylbenzene (E), total Xylenes (X), Methyl Tertiary-Butyl Ether (MTBE), Tertiary-Butyl Alcohol (TBA), Diisopropyl Ether (DIPE), Ethyl Tertiary-Butyl Ether (ETBE), and Tertiary-Amyl Methyl Ether (TAME) analyzed in general accordance with EPA Method Number 8260B.
4. Contains some material lighter than diesel, however, some of this material extends into the diesel range of molecular weights.
5. Contain material in the diesel range of molecular weights, but the material does not exhibit the peak pattern typical of diesel oil. Contain material in the diesel range of molecular weights and beyond. This suggests the presence of an oil heavier than diesel.
6. Includes the reported gasoline components and additives in addition to other peaks in the gasoline range.
7. <: Denotes a value that is "less than" the method detection limit.
8. The gasoline values are primarily from the reported gasoline additives.

4.6 Temporary Injection Point

Initial injection pressure at the shallow injection interval at IP-1 (5-9 feet BGS) was 100 pounds per square inch (psi), which dropped to 50 psi after approximately 1 minute of injection. Flow rate into the formation was approximately 2 gallons per minute (gpm). Injection pressure at the deeper injection interval at IP-1 (10-14 feet BGS) was 25 psi. Flow rate was approximately 1.4 gpm. Groundwater levels were measured in temporary well points at B-101 and B-103 prior to and during injection at IP-1. A slight rise in groundwater levels was observed during injection. Groundwater levels are shown in Table 4.

Table 4
Groundwater Level Measurements, October 4, 2005
Former Rio Dell Texaco, Rio Dell, California

Well Point Location	Time	Distance from Injection Point	Injection Status	Depth to Water (feet BGS) ¹
B-101	14:21	10 Feet	Prior to Injection	7.05
B-101	14:45		During Shallow Interval Injection	7.03
B-101	14:59		End of Shallow Interval Injection	7.00
B-101	15:11		Start of Deeper Interval Injection	6.97
B-101	15:18		End of Deeper Interval Injection	6.95

Table 4
Groundwater Level Measurements, October 4, 2005
Former Rio Dell Texaco, Rio Dell, California

Well Point Location	Time	Distance from Injection Point	Injection Status	Depth to Water (feet BGS¹)
B-102	14:21	14 Feet	Prior to Injection	7.30
B-102	14:45		During Shallow Interval Injection	7.25
B-102	14:59		End of Shallow Interval Injection	7.20
B-102	15:11		Start of Deeper Interval Injection	7.15
B-102	15:18		End of Deeper Interval Injection	7.10

1. BGS: Below Ground Surface

4.7 Chemical Oxidation Treatability Study

Soil and water samples submitted for the chemical oxidation treatability study were treated with activated sodium persulfate and modified Fenton's reagent (hydrogen peroxide and iron catalysts). The most effective treatment chemistry was sodium persulfate activated with sodium hydroxide. This treatment chemistry provided treatment to non-detectable concentrations of petroleum hydrocarbons after a treatment period of 14 weeks. Residual persulfate was also present after 14 weeks. Persulfate would be beneficial in the fine-grained soil at the site, as the treatment chemistry would have additional time to diffuse throughout the treatment area, and oxidize contaminants. The complete treatability study report is included in Appendix E.

5.0 Conclusions and Recommendations

The following conclusions are based on the information previously presented:

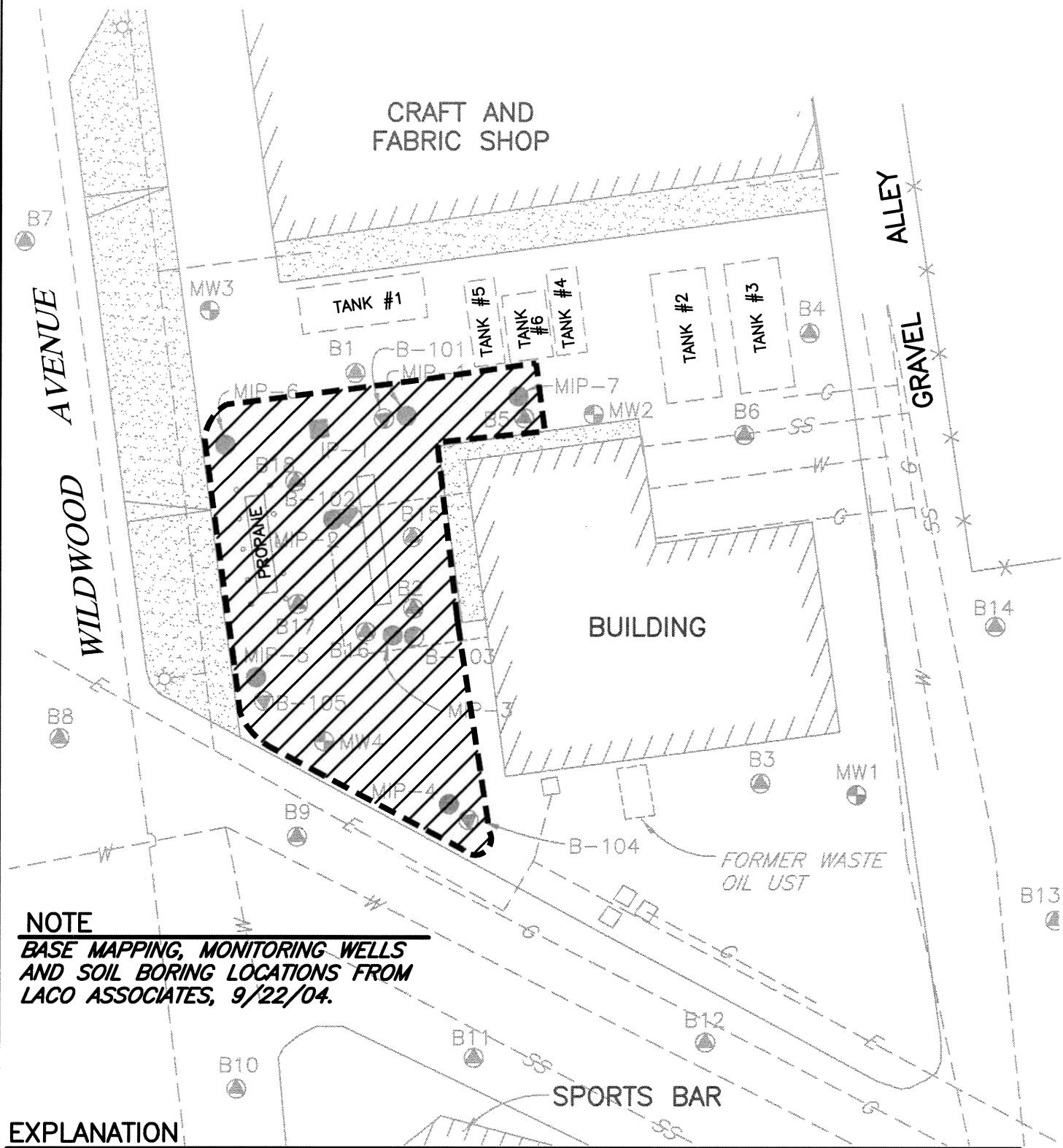
- The vertical and horizontal extent of the contaminant source area has been defined.
- The temporary injection demonstrated the feasibility of injection of remedial fluids into the subsurface.
- Sodium persulfate activated with sodium hydroxide was effective in laboratory tests in the oxidation of contaminants in site soils.

Based on these conclusions, SHN recommends the injection of catalyzed sodium persulfate at the site. Figure 7 shows the proposed injection area. Upon receipt of approval for injection activities, SHN will prepare a report of waste discharge for submittal to the Regional Water Quality Control Board, North Coast Region.

6.0 References Cited

Halford K.J., and E.L. Kuniansky. (2002 *Documentation of Spreadsheets for the Analysis of Aquifer Test and Slug-Test Data*). United States Geological Survey Open File Report 02197. Carson City:USGS.

LACO Associates. (November 1998). *UST Closure Report, Rio Dell Texaco*. Eureka: LACO



EXPLANATION

MW2 MONITORING WELL
B14 LOCATION AND DESIGNATION
B14 SOIL BORING/WELLPOINT
MIP-5 LOCATION AND DESIGNATION (LACO)
B-104 MIP LOCATION AND DESIGNATION
SHN SOIL BORING/WELLPOINT
SHN LOCATION AND DESIGNATION (SHN)

IP-1 **TEMPORARY INJECTION
POINT LOCATION AND DESIGNATION**

B-103 **SOIL BORING LOCATION AND DESIGNATION**

 **PROPOSED INJECTION AREA**

$$1'' = 20'$$

- . (May 2000). *Initial Subsurface Investigation Status Report, Boring and Monitoring Well Installation, Rio Dell Texaco*. Eureka: LACO.
- . (February 2002). *Results of Sensitive Receptor Survey, Former Rio Dell Texaco*. Eureka: LACO.
- . (June 2002). *Subsurface Investigation Status Report, Report of Findings: Boring Installation, Former Rio Dell Texaco*. Eureka: LACO.
- . (February 2004). *Subsurface Investigation Status Report, Former Rio Dell Texaco*. Eureka: LACO.

Appendix A
Field Notes



CONSULTING ENGINEERS & GEOLOGISTS, INC.

480 Hemsted Drive • Redding, CA 96002 • Tel: 530.221.5424 • FAX: 530.221.0135 • E-mail: shninfo@shn-redding.com
812 W. Wabash • Eureka, CA 95501 • Tel: 707.441.8855 • FAX: 707.441.8877 • E-mail: shninfo@shn-enqr.com

DAILY FIELD REPORT

JOB NO
009323

Page | of |

DAILY FIELD REPORT SEQUENCE NO

PROJECT NAME <u>FORMER RIO DELL TEXACO</u>	CLIENT/OWNER		
GENERAL LOCATION OF WORK <u>Rio Dell, CA</u>	OWNER/CLIENT REPRESENTATIVE	DATE <u>10-3-05</u>	DAY OF WEEK <u>MON</u>
TYPE OF WORK <u>MIP / SOIL BORING</u>	WEATHER <u>CLOUDY / RAW</u>	PROJECT ENGINEER/ SUPERVISOR <u>F. Lowman</u>	
SOURCE & DESCRIPTION OF FILL MATERIAL	KEY PERSONS CONTACTED	TECHNICIAN <u>R. Rueban</u>	

DESCRIBE EQUIPMENT USED FOR HAULING, SPREADING, WATERING, CONDITIONING, & COMPACTING

- 800 ON SITE SET UP MIP & WARM UP
 930 START @ MIP-2 MIP-7 (MIP 0073)
 1010 FINISH @ MIP-2 PULL RODS
 1020 START @ MIP-1 (MIP 0074)
 1050 FINISH @ MIP-1 PULL RODS
 1100 @ MIP-6 (MIP-0075)
 1130 FINISH @ MIP-6 PULL RODS
 1145-1215 LUNCH
 1215 SET UP @ MIP-2 (MIP-0076)
 1310 FINISH @ MIP-2 PULL RODS
 1320 @ MIP-3 (MIP 0077)
 1400 FINISH @ MIP-3 PULL RODS (MIP 0078)
 1420 @ MIP-5 (MIP 0079)
 1450 FINISH @ MIP-5 PULL RODS-
 1500 @ MIP-4 (MIP 0079)
 1540 FINISH @ MIP-4 PULL RODS-
 1600 OFFSITE
 ALL MIP HOLES BACKFILLED w/ BENTONITE
 CHIPS & PATCHED w/ NEAT CEMENT

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DAILY FIELD REPORT

JOB NO

004323

Page 1 of 1

PROJECT NAME <i>FORMED Rio Dell Texaco</i>	CLIENT/OWNER	DAILY FIELD REPORT SEQUENCE NO <i>2</i>
GENERAL LOCATION OF WORK <i>Rio Dell, CA</i>	OWNER/CLIENT REPRESENTATIVE	DATE <i>10-4-05</i> DAY OF WEEK <i>TUES</i>
TYPE OF WORK <i>SOIL/ GROUND SAMPLING</i>	WEATHER <i>FOG</i>	PROJECT ENGINEER/ SUPERVISOR <i>F. LOWMAN</i>
SOURCE & DESCRIPTION OF FILL MATERIAL	KEY PERSONS CONTACTED	TECHNICIAN <i>R. Rucker</i>

DESCRIBE EQUIPMENT USED FOR HAULING, SPREADING, WATERING, CONDITIONING, & COMPACTING

8:00	ON SITE - CALIBRATE PID 96 PPM ISOBUTYCAINE
	START @ B-101 - CORE TO 12' COLLECT SOIL & WATER FOR LAB & ISCO BUNCH
9:15	@ B-102 CORE TO 10'
10:15	@ B-103 CORE TO 12'
11:00	@ B-105 - CORE 12-16' COLLECT WATER SAMPLE
12-12 ³⁰	LUNCH
12:30	@ B-104 CORE TO 20' COLLECT SOIL & WATER
14:21	SET UP FOR INJ TEST w/ POTABLE WATER @ 1PSI 1ST INTERVAL 5-9' BGS DTW 7.05' IN B-101 7.30@B-102
14:42	START TEST ~ 60-70 PSI GEOFROSE GS-1000 Grout Pump
14:45	7.03 @ B-101 > .25 @ B-102 ~ 5 GAL DownHole
14:47	PUMP CLOGGED -
14:54	PUMP ON MANUEL
14:59	7.00@B-101 7.20@B-102 ~ 10 GALLONS IN ~ 100 PSI TO BREAK SMART & SO PSI AFTER ~ 2 GPM - Some Breakthrough
15:11	SECOND INTERVAL 10-14' 6.97@B-101 7.15@B-102 ~ 25 PSI
15:18	6.95@B-101 > .10@B-102 ~ 10 GALLONS
	CLEANUP - FILL ALL BORINGS w/ BENTONITE & CAP w/ NEAT CEMENT
16:00	OFF SITE
	5 GALLONS OF DeCON WATER TO SHN

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DAILY FIELD REPORT

JOB NO	004323	
Page	1	of 1

PROJECT NAME <i>Former Rio Dell Texaco</i>	CLIENT/OWNER	DAILY FIELD REPORT SEQUENCE NO
GENERAL LOCATION OF WORK <i>Rio Dell, CA</i>	OWNER/CLIENT REPRESENTATIVE	DATE <i>1-6-06</i> DAY OF WEEK <i>FRI</i>
TYPE OF WORK <i>Slug Test on MWs</i>	WEATHER <i>clear</i>	PROJECT ENGINEER/ SUPERVISOR <i>R. Rueber</i>
SOURCE & DESCRIPTION OF FILL MATERIAL	KEY PERSONS CONTACTED	TECHNICIAN <i>A. Melody</i>

DESCRIBE EQUIPMENT USED FOR HAULING, SPREADING, WATERING, CONDITIONING, & COMPACTING

1145 - Arrive on site, Open MW-1, set up for slug test with Minitroll pressure transducer (down well) direct line to laptop using Win-Situ 4.0 software. (w/2" dia. p. bore) mw-1 4.50					DTW
					BTAC
MW-1	DTW(BTAC)	INT.(sec)	time to recover	DTT	MW-2 4.62
test 1	6.60	0.5sec	2.79 sec	~15.0'	MW-3
2	"	"	2.84	"	MW-4
3	"	"	3.80.5	"	MW-1 6.65
4	"	"	3.43.5	"	
1400 Set up on MW-2 - test as MW-1					
-test 1	3.0'	0.5	541	~14.8'	
2	2.90	0.5	466		
3	2.8095	"	226		
4	2.95	"	406.5		
1530 Set up on MW-4, as MW-1					
test 1	9.60	0.5 sec	139		
2	8.60	"	301.5		
3	8.53	"	190		
4	8.55	"	123		
1620 Off Site					

*All data copied from laptop to H:\ drive *thankfully amelody...*

COPY GIVEN TO:

REPORTED BY:

L. D. Melody

Client Name:

RIO DELL TEXACO

The water from your site:

**100 WILDWOOD AVENUE
RIO DELL, CA LOP # 12691**

SHN ref #

004323

Collected On: **10/4-5/05**

Has been tested and certified as acceptable to be discharged into the City of Eureka municipal sewer system.

Amount Discharged:

5 GALLONS

Date Discharged:

10/28/05

Certified by:

DAVID R. PAINÉ

SHN CONSULTING ENGINEERS & GEOLOGISTS, INC.

City of Eureka Wastewater Discharge Permit #65

Appendix B
MIP/Soil Boring Logs

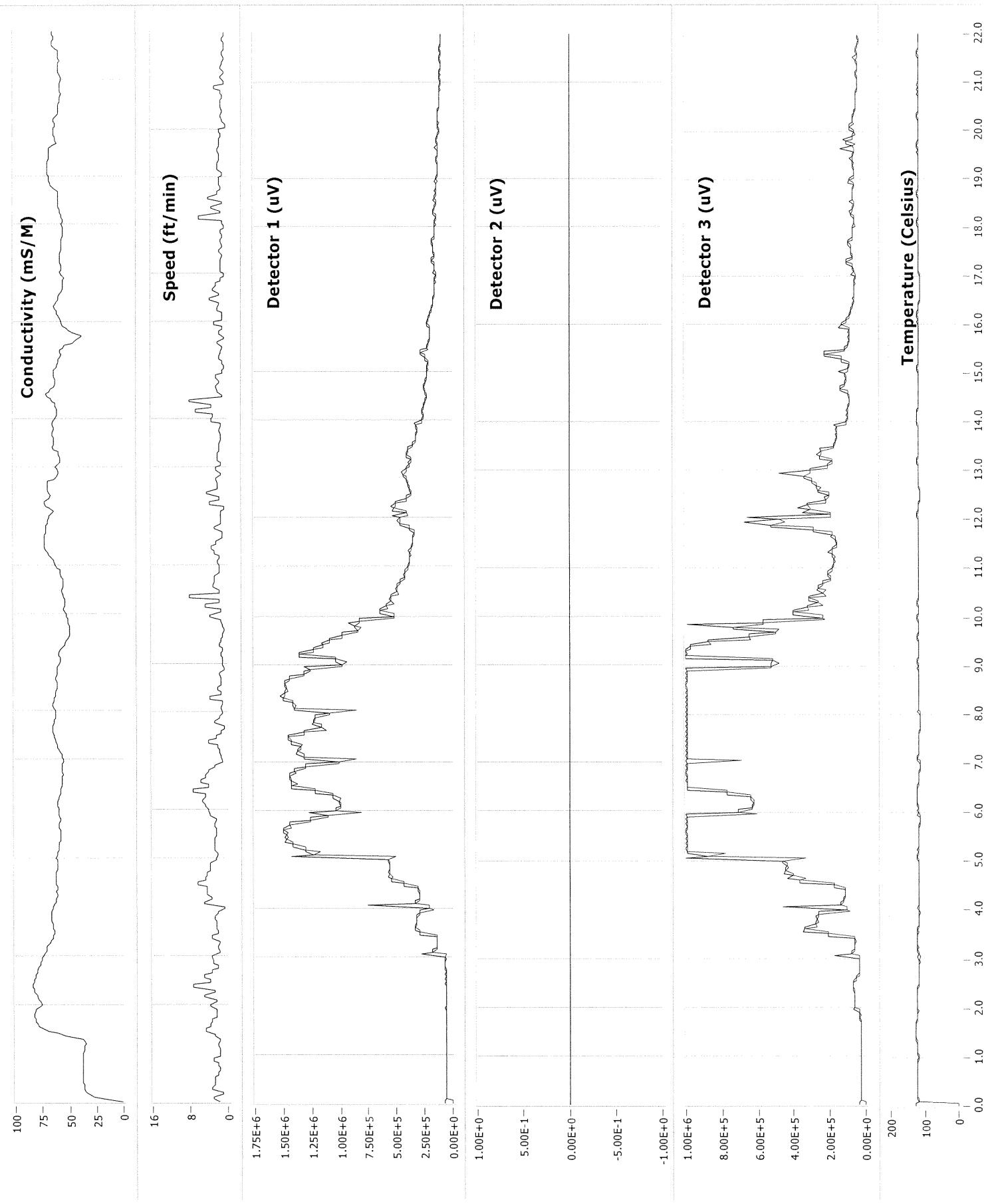
Appendix B

MIP Log Key

y-axis	detector response
x-axis	depth in feet below ground surface
Detector 1	Photo Ionization Detector (PID)
Detector 2	Electron Capture Device (ECD)
Detector 3	Flame Ionization Detector (FID)
(mS/m)	millSiemens per meter
(ft/min)	feet per minute
(uV)	microvolts
Temperature	temperature of the heating block

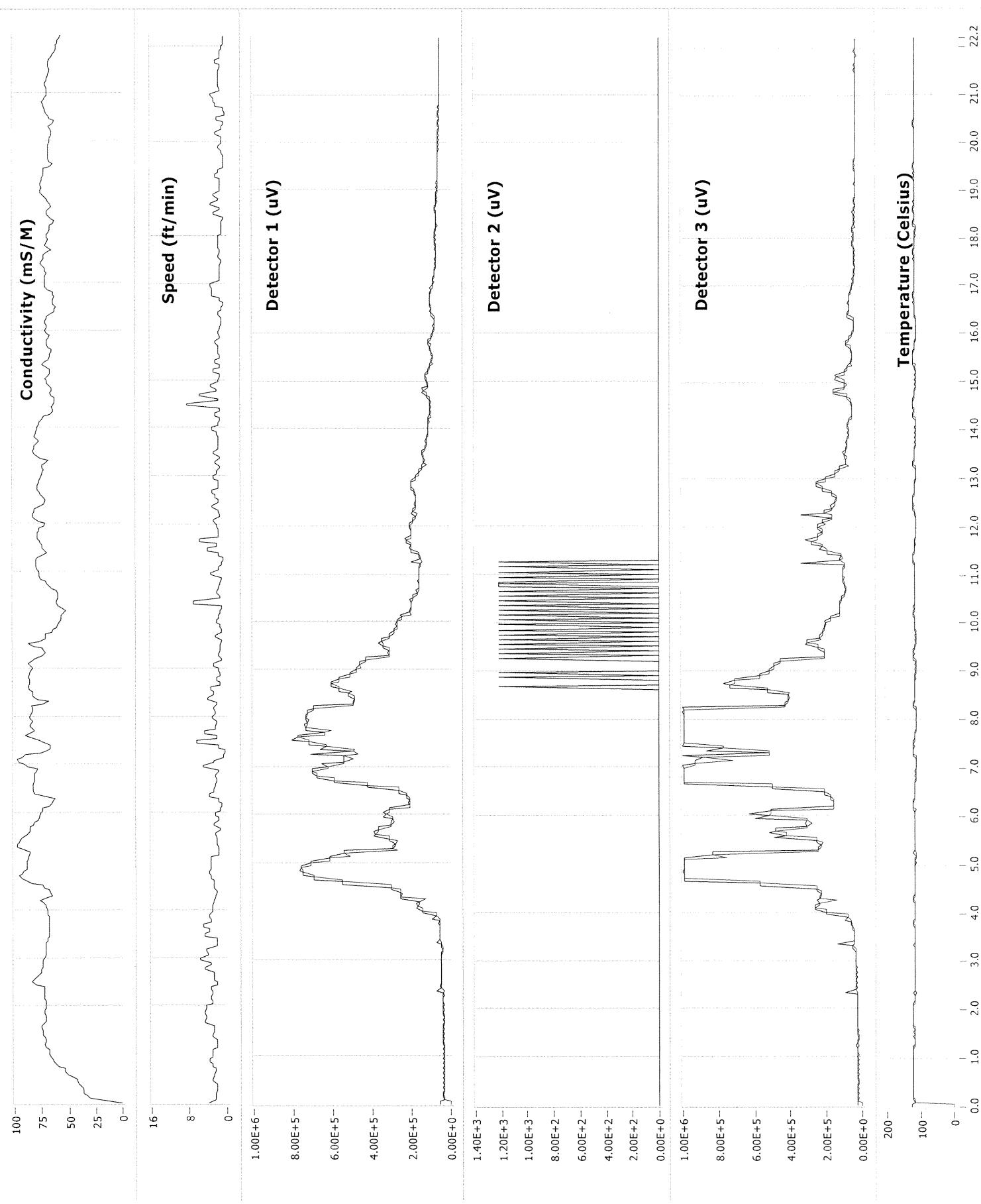
Log: S:\Job-Files\2004\004323riodell\Rio Dell

M\1P - 1



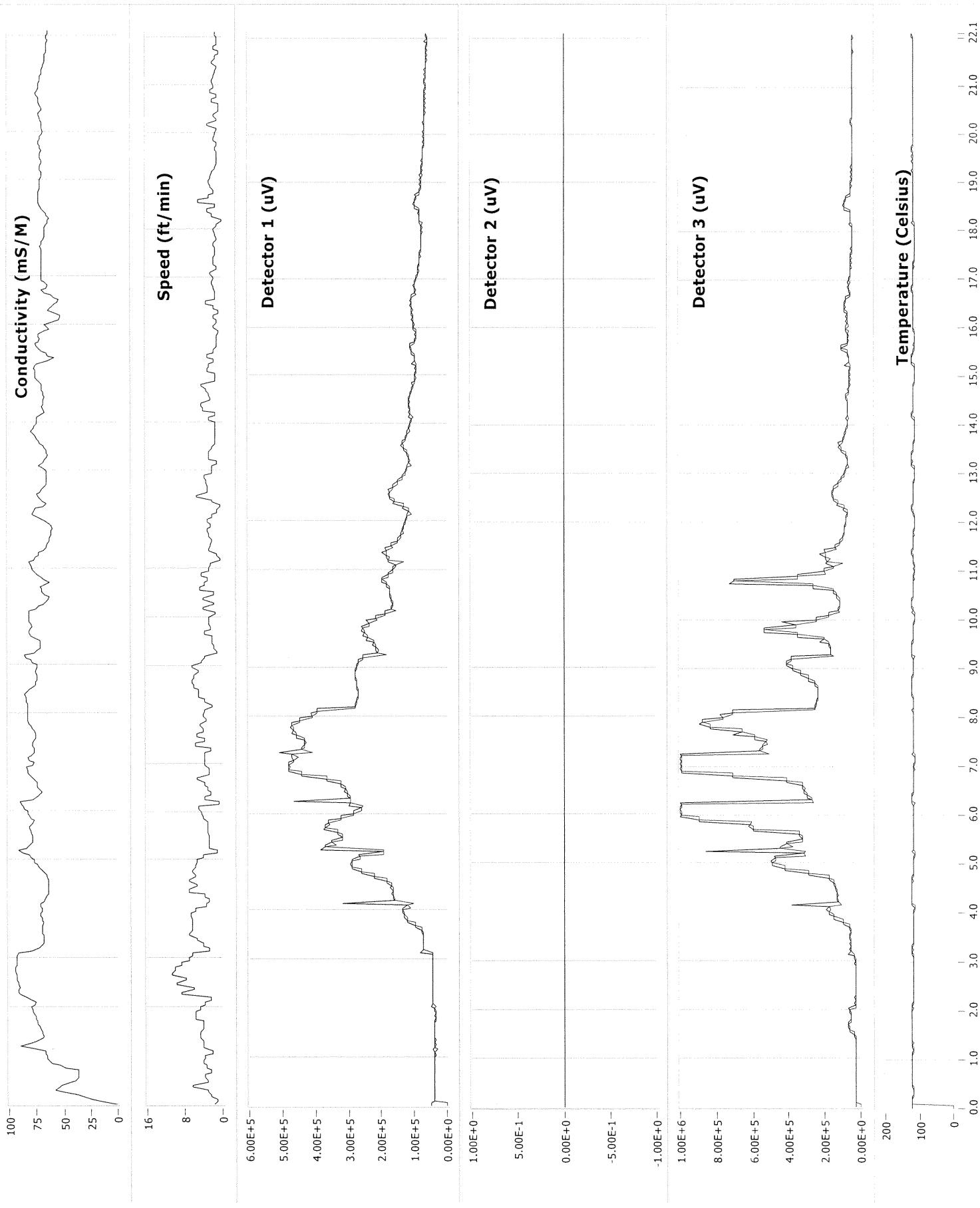
Log: S:\Job-Files\2004\004323riodell\Rio Dell

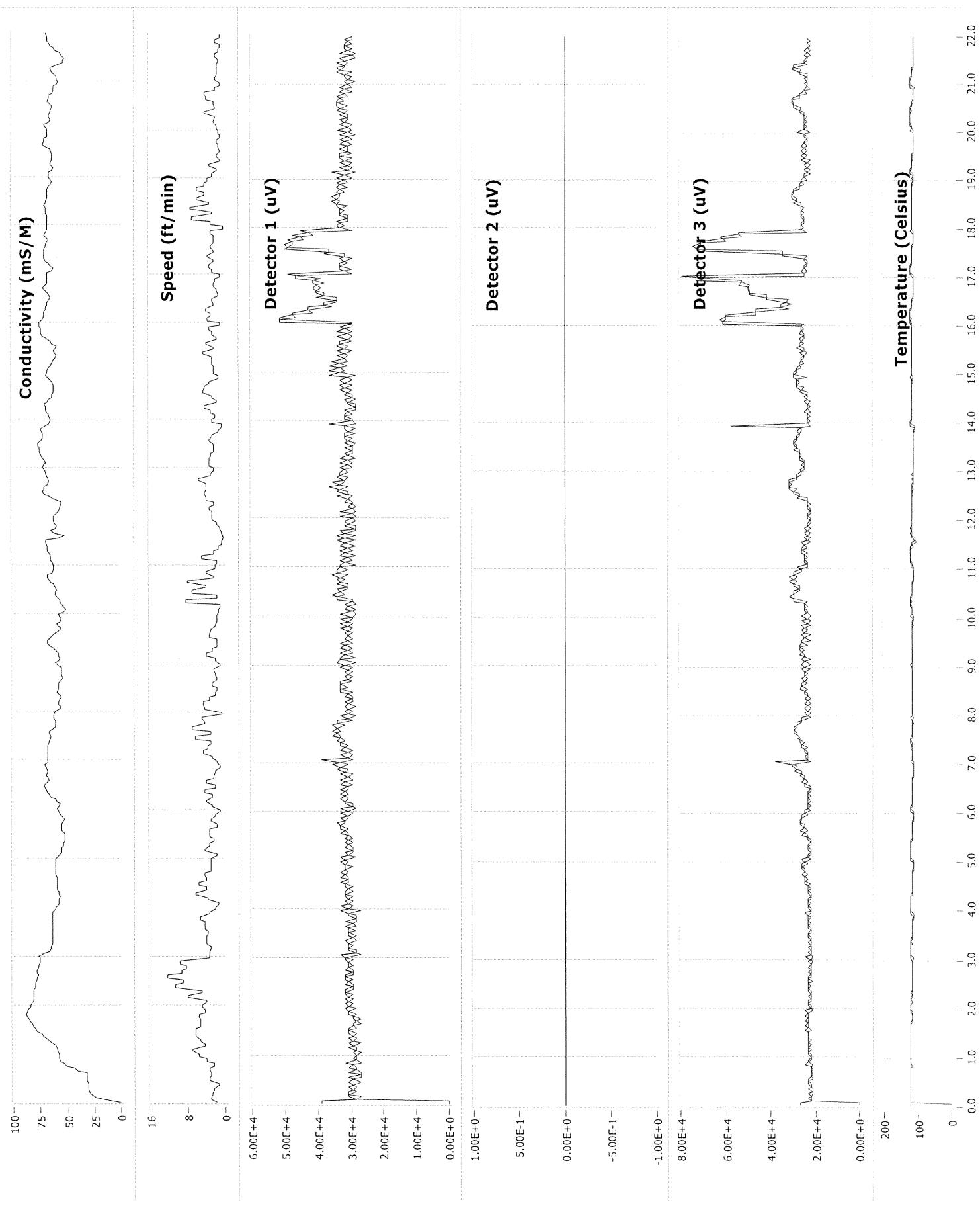
MIP-2



Log: S:\Job-Files\2004\004323riodell\Rio Dell

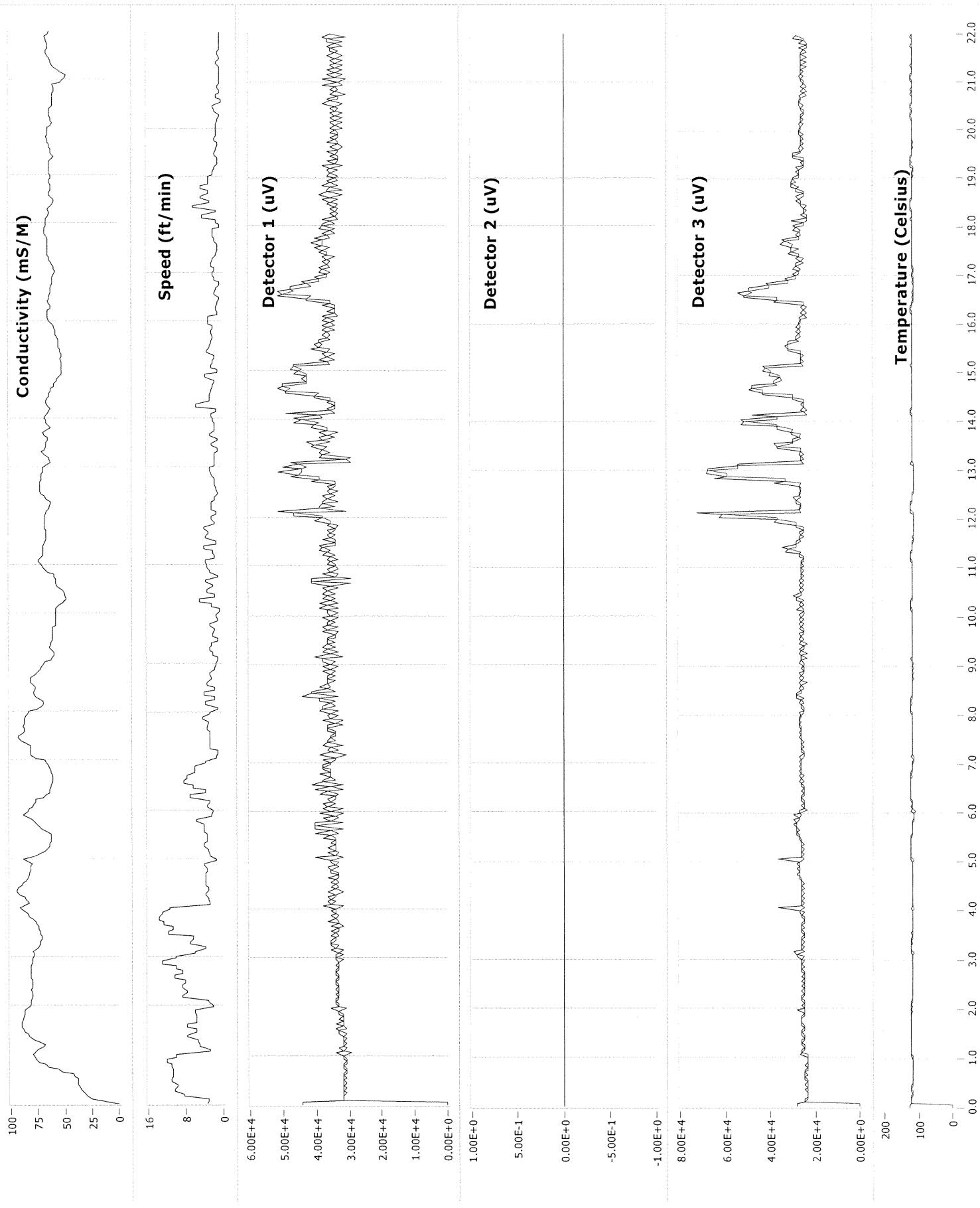
M\T-3

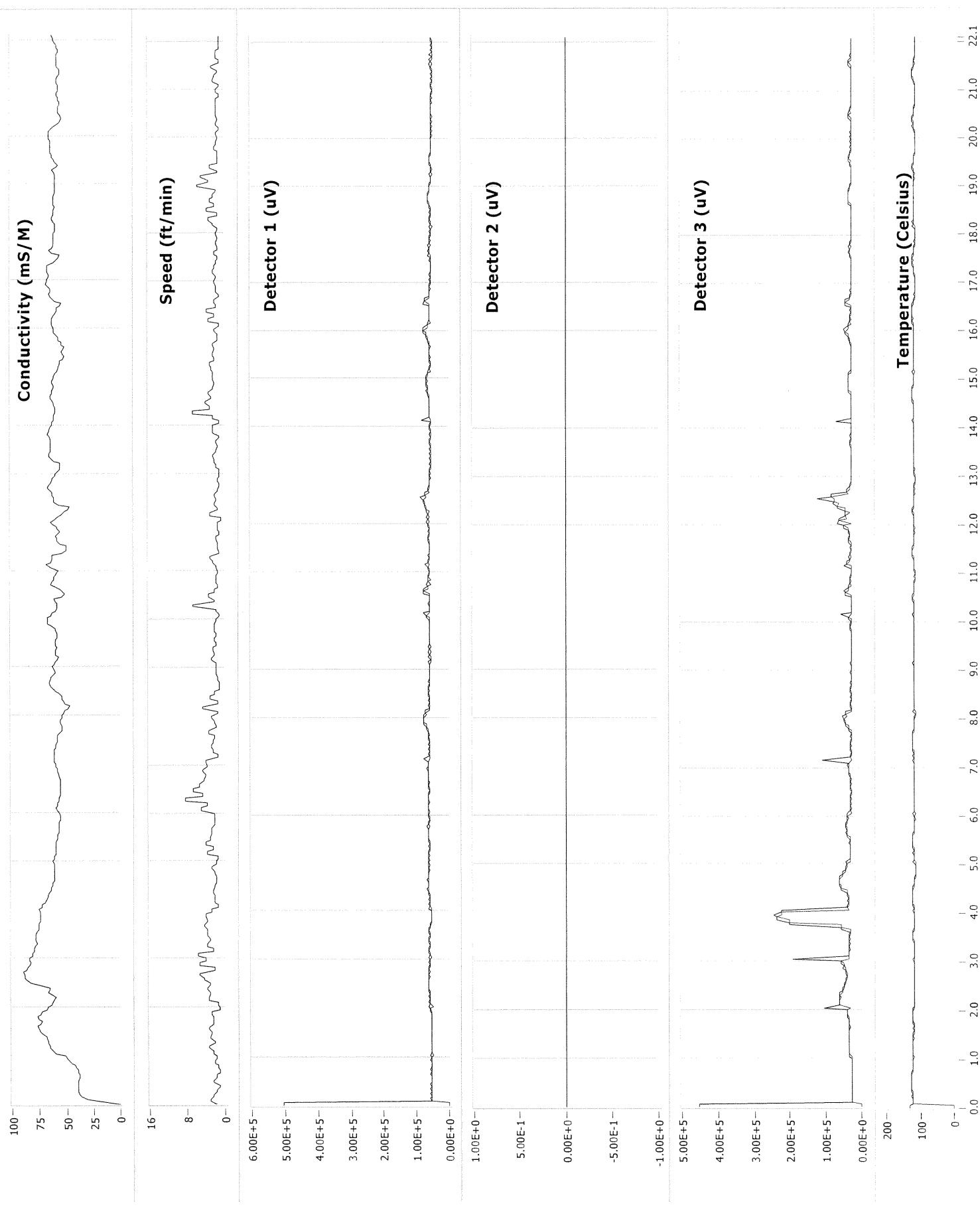




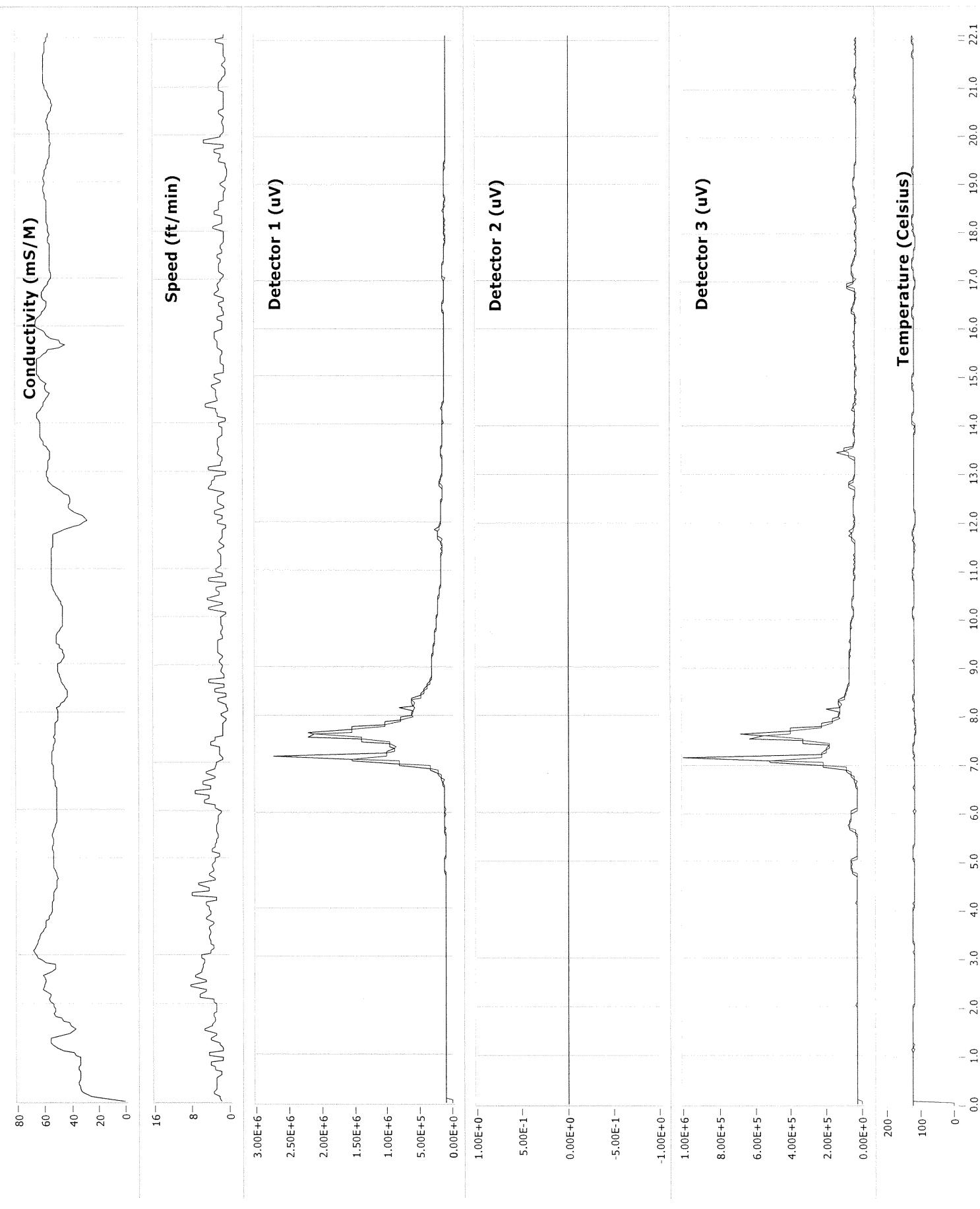
Log: S:\Job-Files\2004\004323riodell\Rio Dell

M\P-5





Log: S:\Job-Files\2004\004323riodell\Rio Dell





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BORING LOG

B-101

PROJ. NAME: Rio Dell Texaco

LOCATION: Rio Dell, CA

PROJ. NUMBER: 004323

DEPTH OF BORING/WELLPOINT: 12.0 / 12.0 Feet BGS

DRILLER: Fisch Environmental

DEPTH TO FIRST WATER: ~7.05 Feet BGS

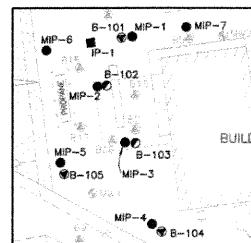
DRILLING METHOD: GeoProbe

SCREEN INTERVAL: 7.0-12.0 Feet BGS

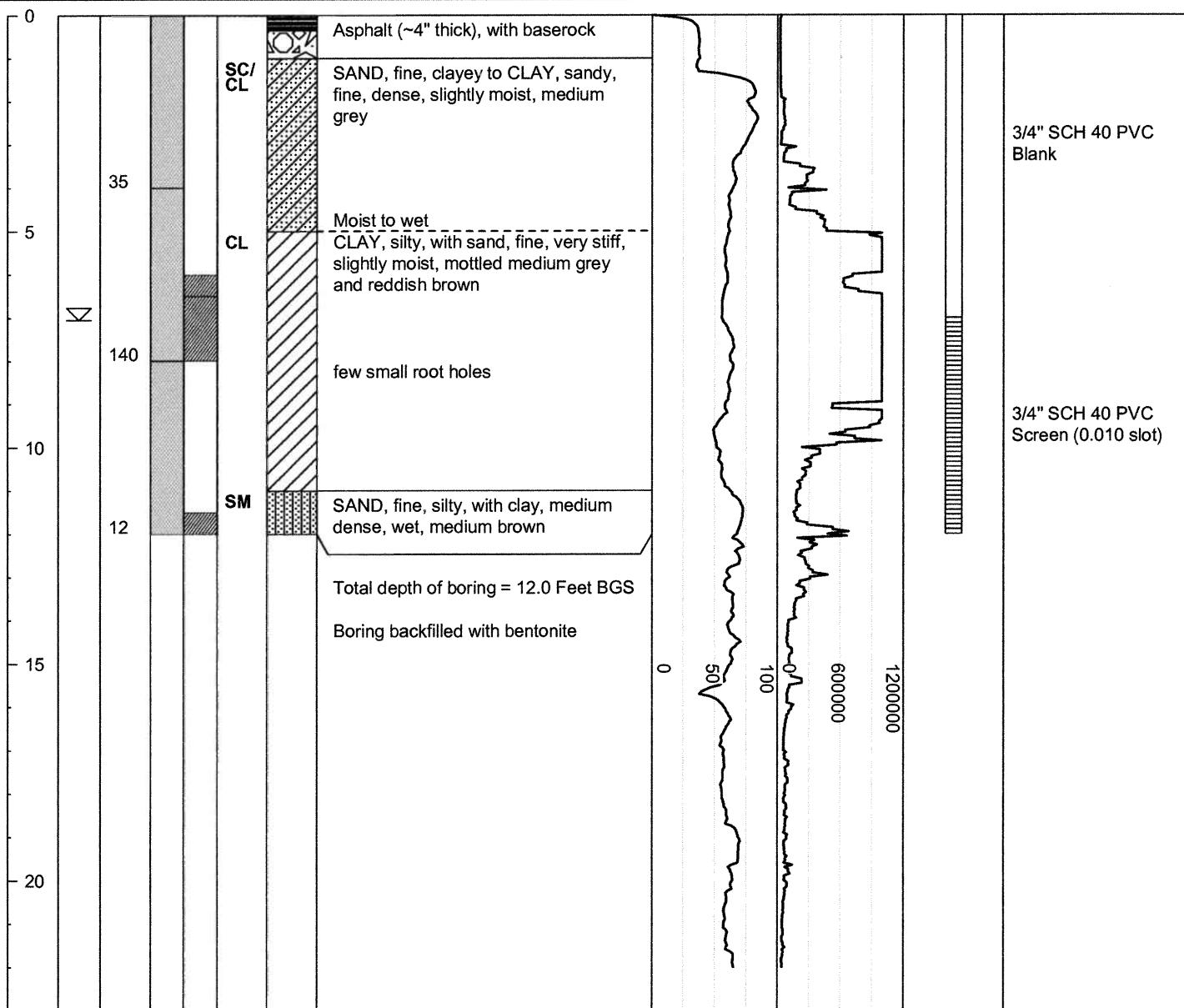
SAMPLER TYPE: Macro Core

DATE: 10/4/05

LOGGED BY: R. Rueber



DEPTH (Feet BGS)	WATER LEVEL	SAMPLE			LITHOLOGY PATTERN	SOIL DESCRIPTION	MIP RESULTS		WELLPOINT CONSTRUCTION	
		OVA READING (ppm)	DRILLING	LABORATORY			Conductivity (mS/m)	FID (micro volts)		
DEPTH (Feet BGS)	WATER LEVEL	OVA READING (ppm)	DRILLING	LABORATORY	USCS	LITHOLOGY PATTERN	SOIL DESCRIPTION	Conductivity (mS/m)	FID (micro volts)	WELLPOINT CONSTRUCTION
0										





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PROJ. NAME: Rio Dell Texaco

LOCATION: Rio Dell, CA

PROJ. NUMBER: 004323

DEPTH OF BORING/WELLPOINT: 16.0 / NA Feet BGS

DRILLER: Fisch Environmental

DEPTH TO FIRST WATER: ~7.4 Feet BGS

DRILLING METHOD: GeoProbe

SCREEN INTERVAL: NA

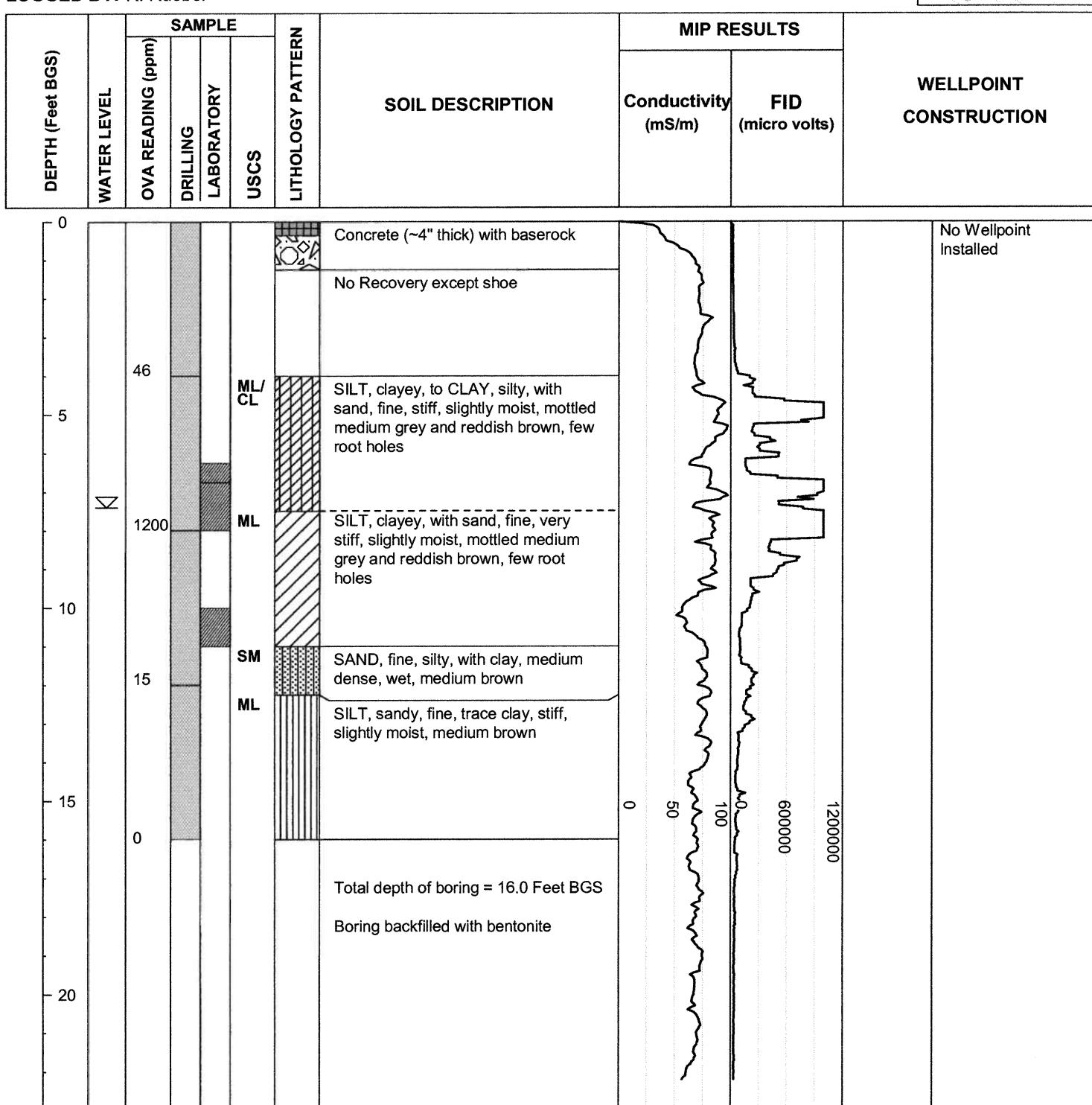
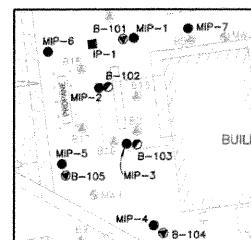
SAMPLER TYPE: Macro Core

DATE: 10/4/05

LOGGED BY: R. Rueber

BORING LOG

B-102





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BORING LOG

B-103

PROJ. NAME: Rio Dell Texaco

LOCATION: Rio Dell, CA

PROJ. NUMBER: 004323

DEPTH OF BORING/WELLPOINT: 14.0 / NA Feet BGS

DRILLER: Fisch Environmental

DEPTH TO FIRST WATER: ~ 11.0 Feet BGS

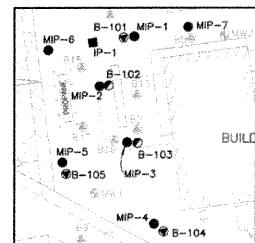
DRILLING METHOD: GeoProbe

SCREEN INTERVAL: NA

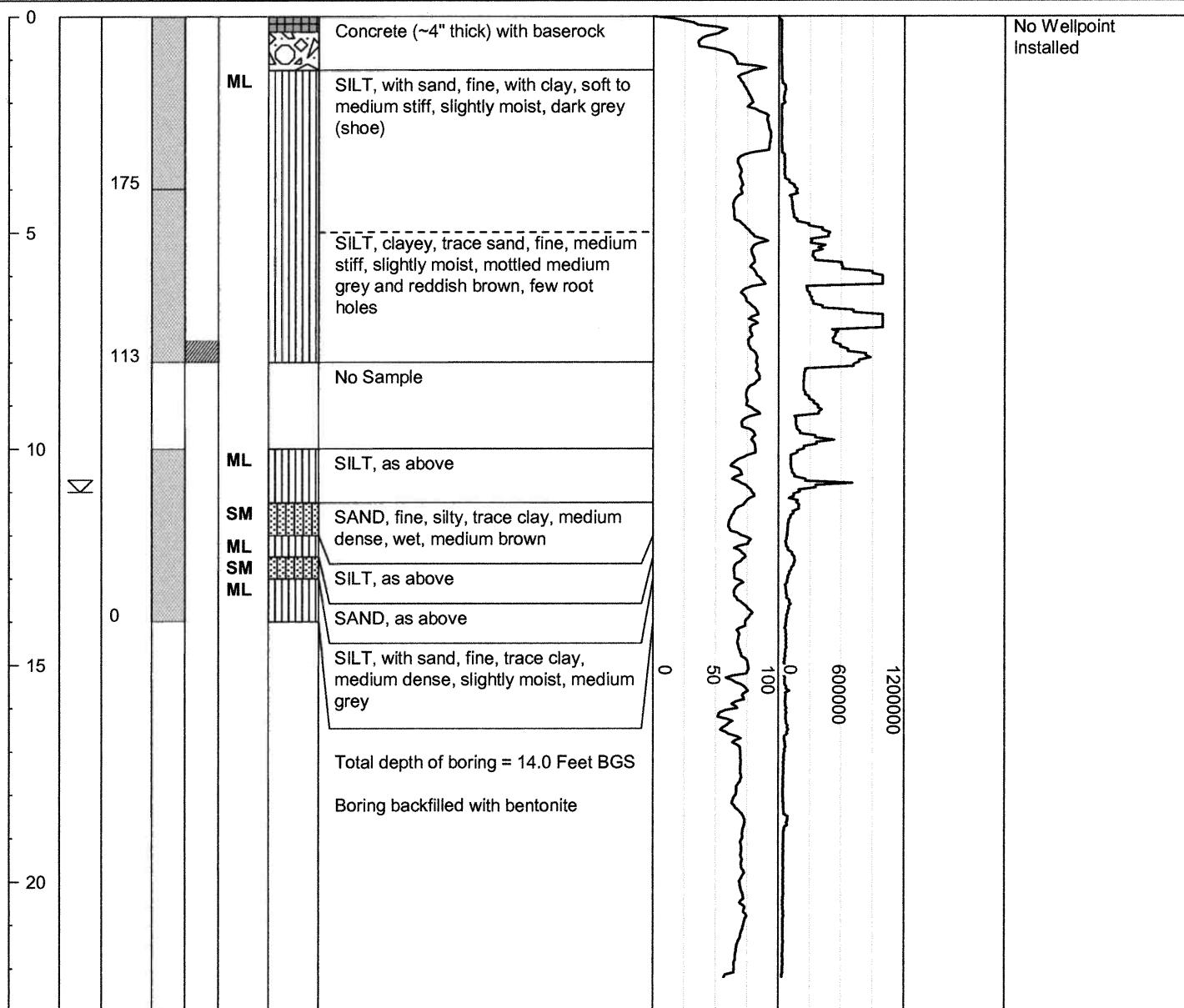
SAMPLER TYPE: Macro Core

DATE: 10/4/05

LOGGED BY: R. Rueber



DEPTH (Feet BGS)	WATER LEVEL	SAMPLE			LITHOLOGY PATTERN	SOIL DESCRIPTION	MIP RESULTS		WELLPOINT CONSTRUCTION
		OVA READING (ppm)	DRILLING	LABORATORY			Conductivity (mS/m)	FID (micro volts)	
0						Concrete (~4" thick) with baserock			
175					ML	SILT, with sand, fine, with clay, soft to medium stiff, slightly moist, dark grey (shoe)			
113						SILT, clayey, trace sand, fine, medium stiff, slightly moist, mottled medium grey and reddish brown, few root holes			
10					ML	No Sample			
9					SM	SILT, as above			
8					ML	SAND, fine, silty, trace clay, medium dense, wet, medium brown			
7					SM	SILT, as above			
6					ML	SAND, as above			
5						SILT, with sand, fine, trace clay, medium dense, slightly moist, medium grey			
0						Total depth of boring = 14.0 Feet BGS			
						Boring backfilled with bentonite			





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PROJ. NAME: Rio Dell Texaco

LOCATION: Rio Dell, CA

PROJ. NUMBER: 004323

DEPTH OF BORING/WELLPOINT: 20.0 / 20.0 Feet BGS

DRILLER: Fisch Environmental

DEPTH TO FIRST WATER: ~10.0 Feet BGS

DRILLING METHOD: GeoProbe

SCREEN INTERVAL: 10.0-20.0 Feet BGS

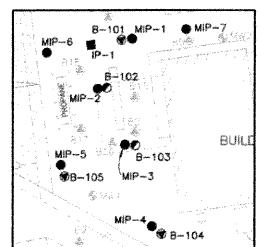
SAMPLER TYPE: Macro Core

DATE: 10/4/05

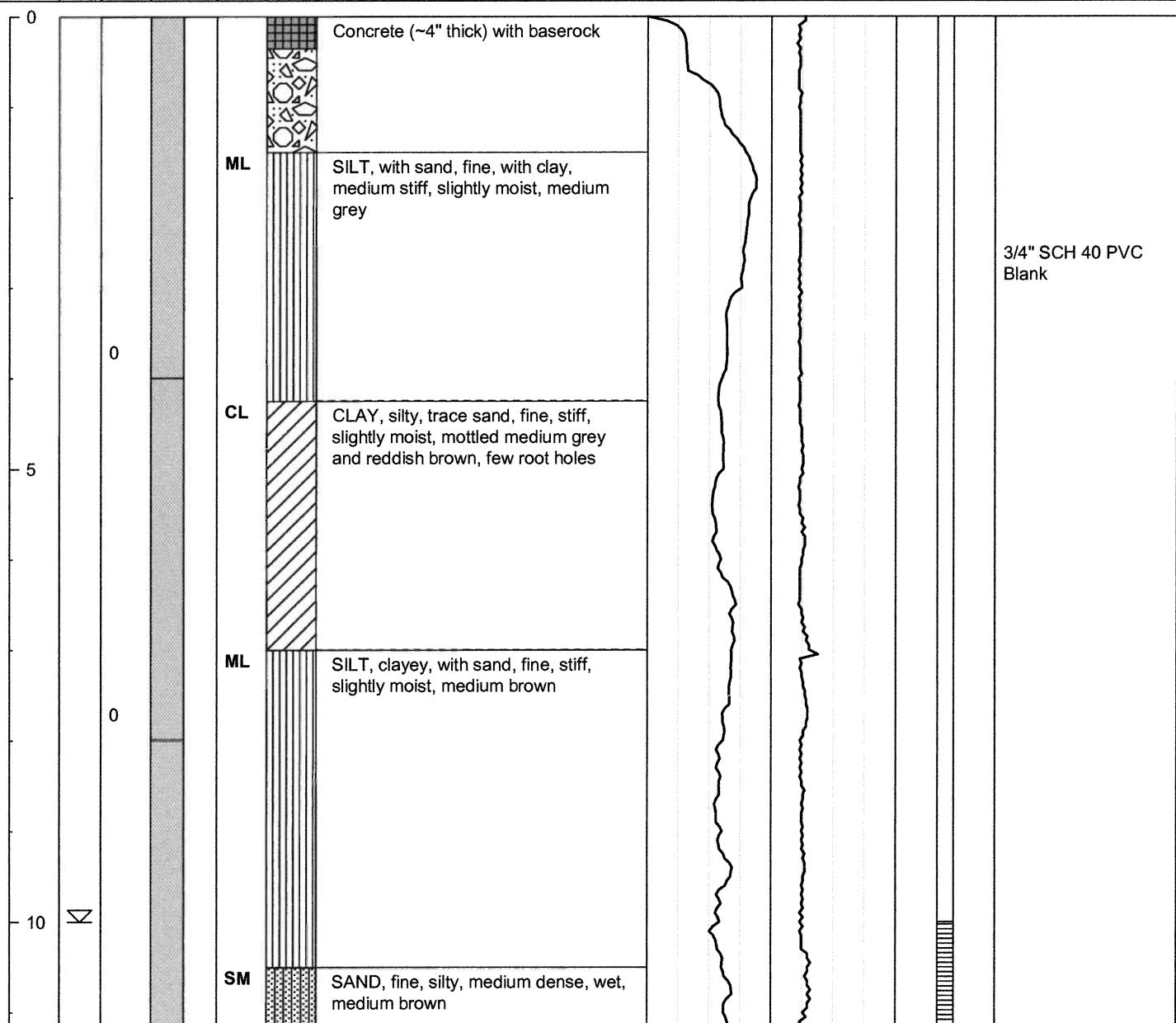
LOGGED BY: R. Rueber

BORING LOG

B-104



DEPTH (Feet BGS)	WATER LEVEL	SAMPLE			LITHOLOGY PATTERN	SOIL DESCRIPTION	MIP RESULTS		WELLPOINT CONSTRUCTION
		OVA READING (ppm)	DRILLING	LABORATORY			Conductivity (mS/m)	FID (micro volts)	
0									





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BORING LOG

B-104

PROJ. NAME: Rio Dell Texaco

LOCATION: Rio Dell, CA

PROJ. NUMBER: 004323

DEPTH OF BORING/WELLPOINT: 20.0 / 20.0 Feet BGS

DRILLER: Fisch Environmental

DEPTH TO FIRST WATER: ~10.0 Feet BGS

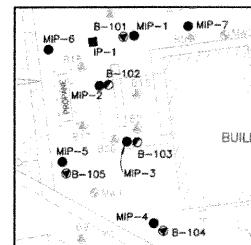
DRILLING METHOD: GeoProbe

SCREEN INTERVAL: 10.0-20.0 Feet BGS

SAMPLER TYPE: Macro Core

DATE: 10/4/05

LOGGED BY: R. Rueber



DEPTH (Feet BGS)	WATER LEVEL	SAMPLE			LITHOLOGY PATTERN	SOIL DESCRIPTION	MIP RESULTS		WELLPOINT CONSTRUCTION	
		OVA READING (ppm)	DRILLING	LABORATORY			Conductivity (mS/m)	FID (micro volts)		
DEPTH (Feet BGS)	WATER LEVEL	OVA READING (ppm)	DRILLING	LABORATORY	USCS	LITHOLOGY PATTERN	SOIL DESCRIPTION	Conductivity (mS/m)	FID (micro volts)	WELLPOINT CONSTRUCTION
0	0				ML	SILT, as above, trace clay/sand, fine				
15	0				GM	GRAVEL, fine, rounded, sandy, fine, silty, trace clay, med dense, wet, med brown				
					SM	SAND, as above				
					ML	SILT, as above				
					SM	SAND, as above				
					ML	SILT, sandy, fine, stiff, slightly moist, medium grey				
					SM	SAND, as above				
					ML	SILT, with sand, fine, stiff, slightly moist, dark grey				
20	0					Total depth of boring = 20.0 Feet BGS				3/4" SCH 40 PVC Screen (0.010 slot)
						Boring backfilled with bentonite				



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BORING LOG B-105

PROJ. NAME: Rio Dell Texaco

LOCATION: Rio Dell, CA

PROJ. NUMBER: 004323

DEPTH OF BORING/WELLPOINT: 16.0 / 16.0 Feet BGS

DRILLER: Fisch Environmental

DEPTH TO FIRST WATER: ~11.0 Feet BGS

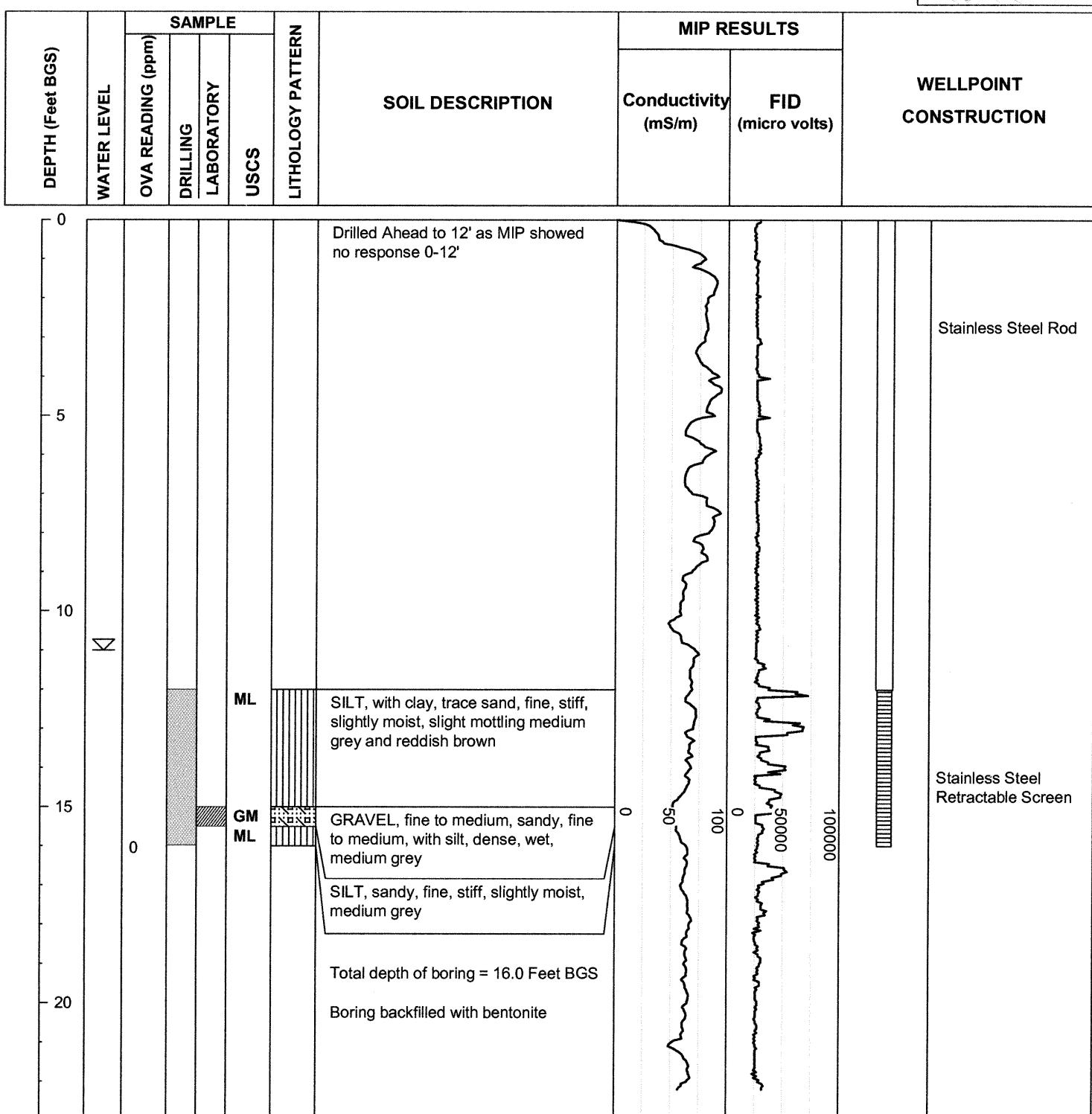
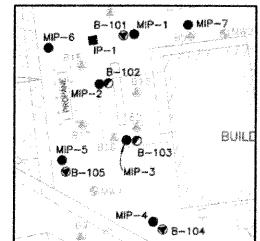
DRILLING METHOD: GeoProbe

SCREEN INTERVAL: 12.0-16.0 Feet BGS

SAMPLER TYPE: Macro Core

DATE: 10/4/05

LOGGED BY: R. Rueber





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PROJ. NAME: Rio Dell Texaco

LOCATION: Rio Dell, CA

PROJ. NUMBER: 004323

DEPTH OF BORING/WELLPOINT: 22.0 / NA Feet BGS

DRILLER: Fisch Environmental

DEPTH TO FIRST WATER: -- Feet BGS

DRILLING METHOD: GeoProbe

SCREEN INTERVAL: NA

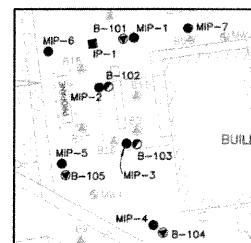
SAMPLER TYPE: NA

DATE: 10/4/05

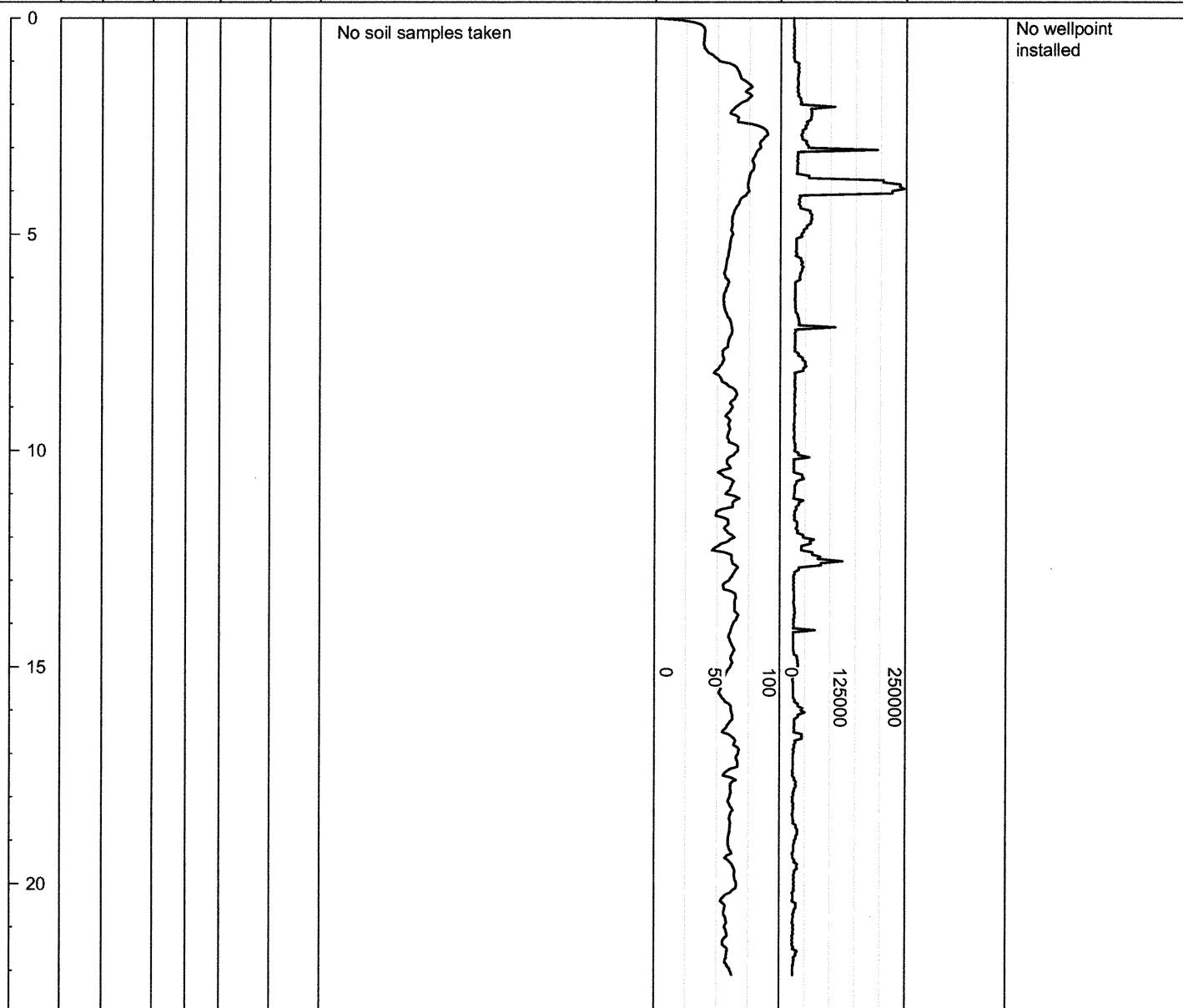
LOGGED BY: R. Rueber

BORING LOG

MIP-6



DEPTH (Feet BGS)	WATER LEVEL	SAMPLE		LITHOLOGY PATTERN	SOIL DESCRIPTION	MIP RESULTS		WELLPOINT CONSTRUCTION
		OVA READING (ppm)	DRILLING LABORATORY USCS			Conductivity (mS/m)	FID (micro volts)	
0					No soil samples taken			No wellpoint installed





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PROJ. NAME: Rio Dell Texaco

LOCATION: Rio Dell, CA

PROJ. NUMBER: 004323

DEPTH OF BORING/WELLPOINT: 22.0 / NA Feet BGS

DRILLER: Fisch Environmental

DEPTH TO FIRST WATER: -- Feet BGS

DRILLING METHOD: GeoProbe

SCREEN INTERVAL: NA

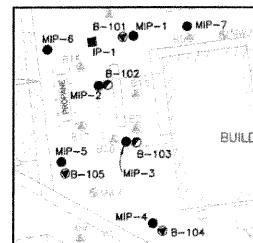
SAMPLER TYPE: NA

DATE: 10/4/05

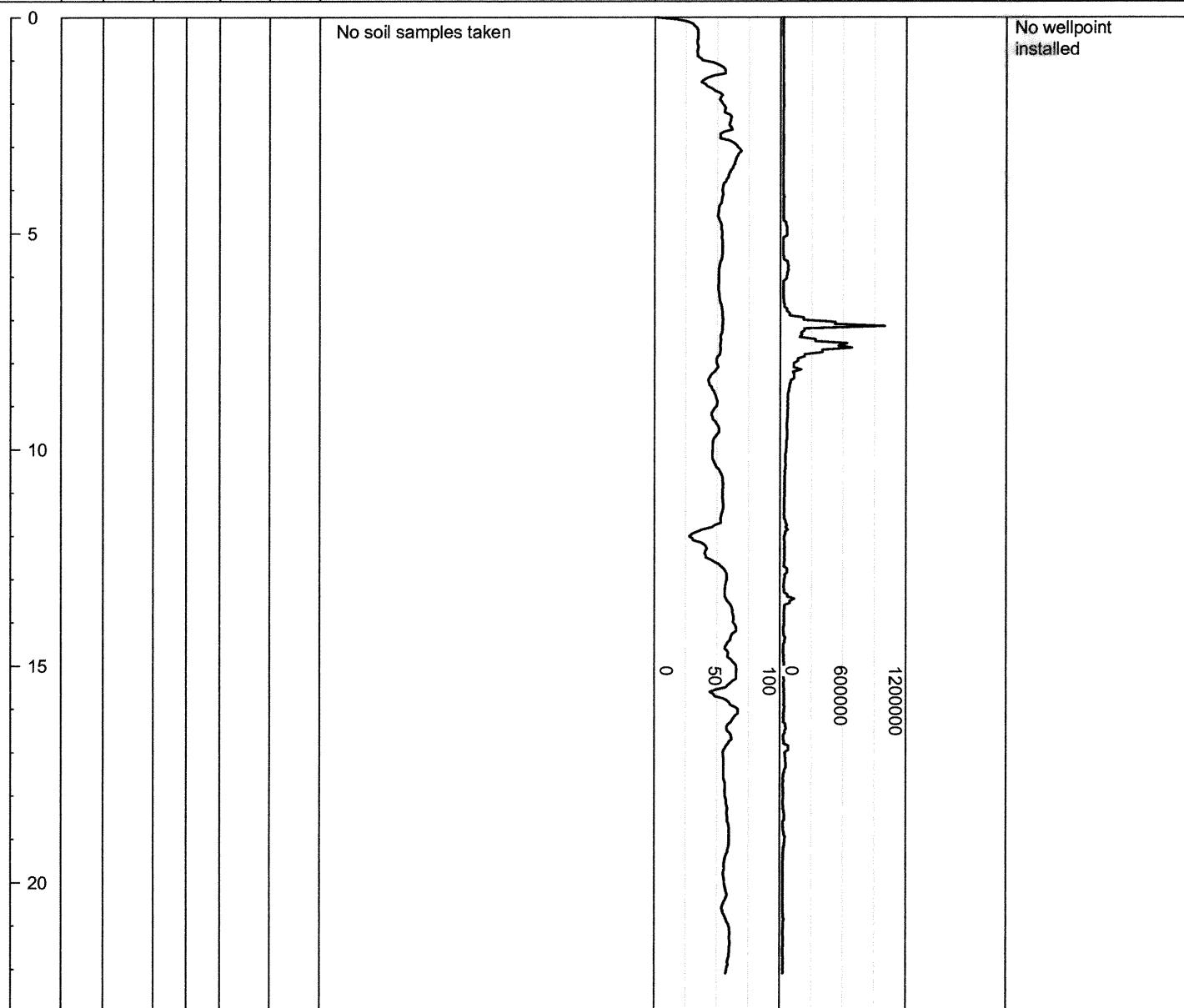
LOGGED BY: R. Rueber

BORING LOG

MIP-7



DEPTH (Feet BGS)	SAMPLE				SOIL DESCRIPTION	MIP RESULTS		WELLPOINT CONSTRUCTION
	WATER LEVEL	OVA READING (ppm)	DRILLING	LABORATORY		Conductivity (mS/m)	FID (micro volts)	
USCS					No soil samples taken			No wellpoint installed



Appendix C
Slug Test Data

WELL ID: Rio Dell Texaco

Local ID: MW-1, Run 2

Date: 1/6/2006

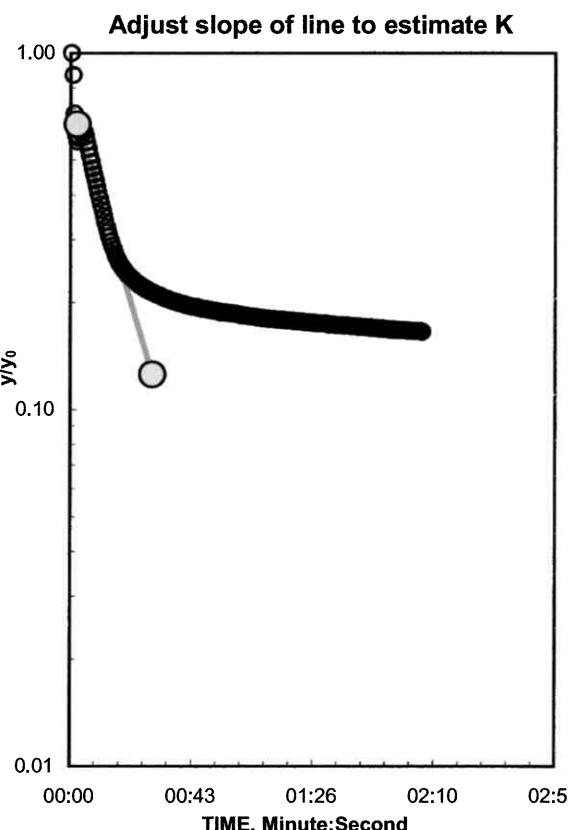
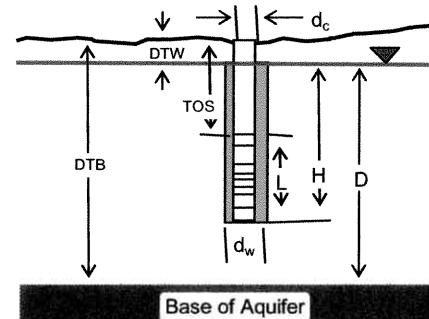
Time: 0:00

INPUT	
Construction:	
Casing dia. (d_c)	2 Inch
Annulus dia. (d_w)	8.25 Inch
Screen Length (L)	10 Feet
Depths to:	
water level (DTW)	6.6 Feet
top of screen (TOS)	5 Feet
Base of Aquifer (DTB)	25 Feet
Annular Fill:	
across screen --	Medium Sand
above screen --	Bentonite
Aquifer Material --	
Fine Sand	

COMPUTED	
L_{wetted}	8.4 Feet
D =	18.4 Feet
H =	8.4 Feet
L/r_w =	24.44
y_0 -DISPLACEMENT =	2.18 Feet
y_0 -SLUG =	2.30 Feet
From look-up table using L/r_w	
Partial penetrate A =	2.347
B =	0.380
$\ln(Re/rw)$ =	2.030
Re =	2.62 Feet
Slope =	0.02621 \log_{10}/sec
$t_{90\%}$ recovery =	38 sec

Input is consistent.

K =	4.4 Feet/Day
-----	--------------



REMARKS:

Bouwer and Rice analysis of slug test, WRR 1976

--

Reduced Data		
	Time, Hr:Min:Sec	Water Level
Entry		
1	0:00:15.5	6.15
2	0:00:18.0	7.07
3	0:00:20.5	7.06
4	0:00:23.0	7.30
5	0:00:25.5	7.48
6	0:00:28.0	7.62
7	0:00:30.5	7.72
8	0:00:33.0	7.78
9	0:00:35.5	7.81
10	0:00:38.0	7.83
11	0:00:40.5	7.85
12	0:00:43.0	7.86
13	0:00:45.5	7.87
14	0:00:48.0	7.88
15	0:00:50.5	7.89
16	0:00:53.0	7.89
17	0:00:55.5	7.90
18	0:00:58.0	7.91
19	0:01:00.5	7.91
20	0:01:03.0	7.91
21	0:01:05.5	7.92
22	0:01:08.0	7.92
23	0:01:10.5	7.92
24	0:01:13.0	7.93
25	0:01:15.5	7.93
26	0:01:18.0	7.93
27	0:01:20.5	7.93
28	0:01:23.0	7.94
29	0:01:25.5	7.94
30	0:01:28.0	7.94
31	0:01:30.5	7.94
32	0:01:33.0	7.94
33	0:01:35.5	7.95
34	0:01:38.0	7.95
35	0:01:40.5	7.95
36	0:01:43.0	7.95
37	0:01:45.5	7.95
38	0:01:48.0	7.95
39	0:01:50.5	7.96
40	0:01:53.0	7.96
41	0:01:55.5	7.96
42	0:01:58.0	7.96
43	0:02:00.5	7.96
44	0:02:03.0	7.96
45	0:02:05.5	7.96

WELL ID: Rio Dell Texaco

Local ID: MW-1, Run 3

Date: 1/6/2006

Time: 0:00

INPUT

Construction:	
Casing dia. (d_c)	2 Inch
Annulus dia. (d_w)	8.25 Inch
Screen Length (L)	10 Feet
Depths to:	
water level (DTW)	6.6 Feet
top of screen (TOS)	5 Feet
Base of Aquifer (DTB)	25 Feet
Annular Fill:	
across screen --	Medium Sand
above screen --	Bentonite
Aquifer Material -- Fine Sand	

COMPUTED

$$\begin{aligned} L_{wetted} &= 8.4 \text{ Feet} \\ D &= 18.4 \text{ Feet} \\ H &= 8.4 \text{ Feet} \\ L/r_w &= 24.44 \\ y_0\text{-DISPLACEMENT} &= 2.95 \text{ Feet} \\ y_0\text{-SLUG} &= 3.00 \text{ Feet} \end{aligned}$$

From look-up table using L/r_w

$$\begin{aligned} \text{Partial penetrate A} &= 2.347 \\ B &= 0.380 \end{aligned}$$

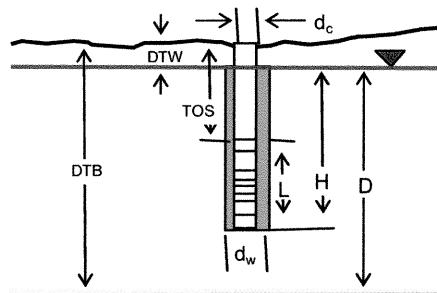
$$\begin{aligned} \ln(Re/r_w) &= 2.030 \\ Re &= 2.62 \text{ Feet} \end{aligned}$$

$$\text{Slope} = 0.029122 \log_{10}/\text{sec}$$

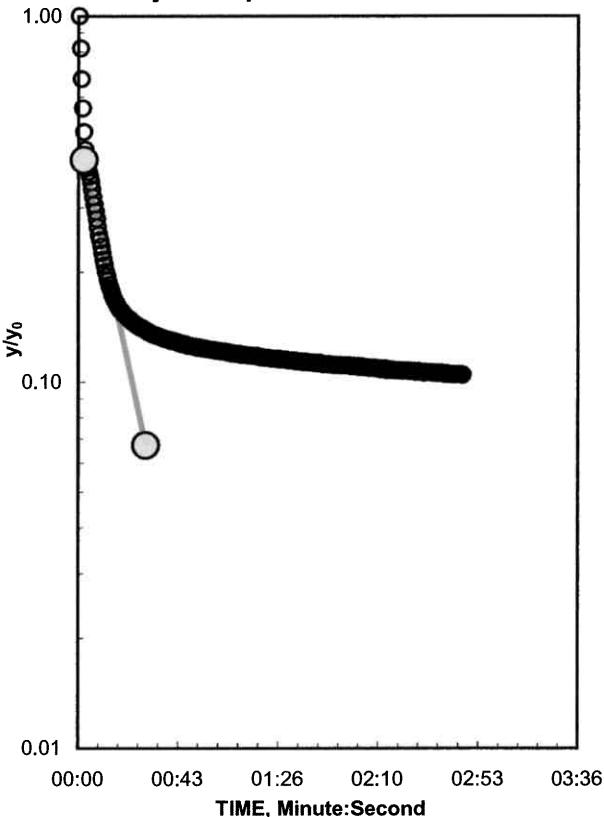
$$t_{90\%} \text{ recovery} = 34 \text{ sec}$$

Input is consistent.

$$K = 4.9 \text{ Feet/Day}$$



Adjust slope of line to estimate K



REMARKS:

Bouwer and Rice analysis of slug test, 1

Reduced Data

Entry	Time,	Water
	Hr:Min:Sec	Level
1	0:00:10.5	5.38
2	0:00:14.0	7.19
3	0:00:17.5	7.47
4	0:00:21.0	7.69
5	0:00:24.5	7.81
6	0:00:28.0	7.86
7	0:00:31.5	7.89
8	0:00:35.0	7.91
9	0:00:38.5	7.92
10	0:00:42.0	7.93
11	0:00:45.5	7.94
12	0:00:49.0	7.95
13	0:00:52.5	7.95
14	0:00:56.0	7.96
15	0:00:59.5	7.96
16	0:01:03.0	7.96
17	0:01:06.5	7.97
18	0:01:10.0	7.97
19	0:01:13.5	7.97
20	0:01:17.0	7.98
21	0:01:20.5	7.98
22	0:01:24.0	7.98
23	0:01:27.5	7.98
24	0:01:31.0	7.99
25	0:01:34.5	7.99
26	0:01:38.0	7.99
27	0:01:41.5	7.99
28	0:01:45.0	7.99
29	0:01:48.5	8.00
30	0:01:52.0	8.00
31	0:01:55.5	8.00
32	0:01:59.0	8.00
33	0:02:02.5	8.00
34	0:02:06.0	8.00
35	0:02:09.5	8.01
36	0:02:13.0	8.01
37	0:02:16.5	8.01
38	0:02:20.0	8.01
39	0:02:23.5	8.01
40	0:02:27.0	8.01
41	0:02:30.5	8.01
42	0:02:34.0	8.02
43	0:02:37.5	8.02
44	0:02:41.0	8.02
45	0:02:44.5	8.02

WRR 1976

WELL ID: Rio Dell Texaco

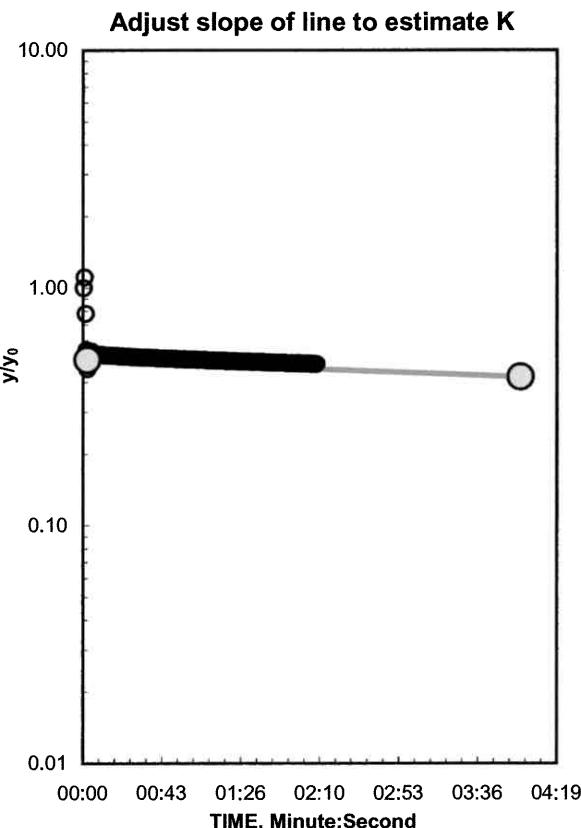
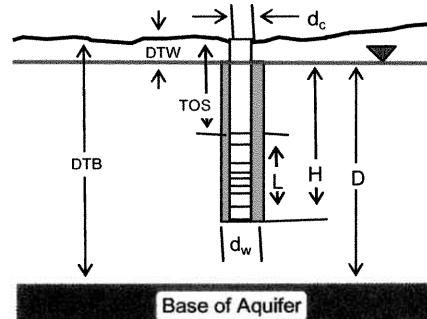
Local ID: MW-2, Run 2

Date: 1/6/2006

Time: 0:00

INPUT	
Construction:	
Casing dia. (d_c)	2 Inch
Annulus dia. (d_w)	8.25 Inch
Screen Length (L)	10 Feet
Depths to:	
water level (DTW)	2.99 Feet
top of screen (TOS)	5 Feet
Base of Aquifer (DTB)	25 Feet
Annular Fill:	
across screen --	Medium Sand
above screen --	Bentonite
Aquifer Material -- Clay soils (surface)	

COMPUTED	
L_{wetted}	10 Feet
D =	22.01 Feet
H =	12.01 Feet
L/r_w =	29.09
y_0 -DISPLACEMENT =	2.78 Feet
y_0 -SLUG =	3.00 Feet
From look-up table using L/r_w	
Partial penetrate A =	2.480
B =	0.409
$\ln(Re/rw)$ =	2.261
Re =	3.30 Feet
Slope =	0.000296 \log_{10}/sec
$t_{90\%}$ recovery =	3382 sec
Input is consistent.	
K = 0.046 Feet/Day	



REMARKS:

Bouwer and Rice analysis of slug test, WRR 1976

Reduced Data		
	Time, Hr:Min:Sec	Water Level
Entry		
1	0:00:11.5	9.14
2	0:00:14.0	10.61
3	0:00:16.5	10.45
4	0:00:19.0	10.46
5	0:00:21.5	10.47
6	0:00:24.0	10.47
7	0:00:26.5	10.48
8	0:00:29.0	10.48
9	0:00:31.5	10.49
10	0:00:34.0	10.49
11	0:00:36.5	10.49
12	0:00:39.0	10.50
13	0:00:41.5	10.50
14	0:00:44.0	10.50
15	0:00:46.5	10.51
16	0:00:49.0	10.51
17	0:00:51.5	10.51
18	0:00:54.0	10.51
19	0:00:56.5	10.52
20	0:00:59.0	10.52
21	0:01:01.5	10.52
22	0:01:04.0	10.53
23	0:01:06.5	10.53
24	0:01:09.0	10.53
25	0:01:11.5	10.53
26	0:01:14.0	10.53
27	0:01:16.5	10.54
28	0:01:19.0	10.54
29	0:01:21.5	10.54
30	0:01:24.0	10.55
31	0:01:26.5	10.55
32	0:01:29.0	10.55
33	0:01:31.5	10.55
34	0:01:34.0	10.55
35	0:01:36.5	10.56
36	0:01:39.0	10.56
37	0:01:41.5	10.56
38	0:01:44.0	10.56
39	0:01:46.5	10.56
40	0:01:49.0	10.57
41	0:01:51.5	10.57
42	0:01:54.0	10.57
43	0:01:56.5	10.57
44	0:01:59.0	10.57
45	0:02:01.5	10.58

WELL ID: Rio Dell Texaco

Local ID: MW-2, Run 1

Date: 1/6/2006

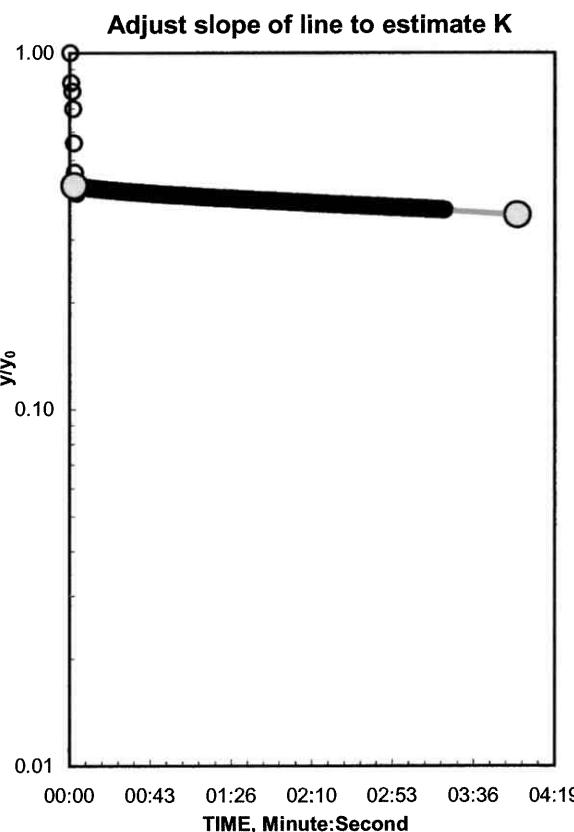
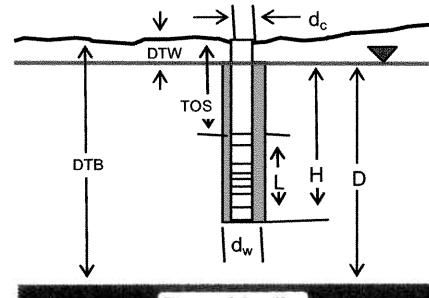
Time: 0:00

INPUT	
Construction:	
Casing dia. (d_c)	2 Inch
Annulus dia. (d_w)	8.25 Inch
Screen Length (L)	10 Feet
Depths to:	
water level (DTW)	2.99 Feet
top of screen (TOS)	5 Feet
Base of Aquifer (DTB)	25 Feet
Annular Fill:	
across screen --	Medium Sand
above screen --	Bentonite
Aquifer Material -- Clay soils (surface)	

COMPUTED	
L_{wetted}	10 Feet
D =	22.01 Feet
H =	12.01 Feet
L/r_w =	29.09
y_0 -DISPLACEMENT =	3.89 Feet
y_0 -SLUG =	3.63 Feet
From look-up table using L/r_w	
Partial penetrate A =	2.480
B =	0.409
$\ln(Re/rw)$ =	2.261
Re =	3.30 Feet
Slope =	0.000351 \log_{10}/sec
$t_{90\%}$ recovery =	2852 sec

Input is consistent.

K = 0.055 Feet/Day



REMARKS:

Bouwer and Rice analysis of slug test, WRR 1976

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Reduced Data		
	Time, Hr:Min:Sec	Water Level
Entry		
1	0:00:59.5	7.92
2	0:01:03.5	10.23
3	0:01:07.5	10.18
4	0:01:11.5	10.19
5	0:01:15.5	10.20
6	0:01:19.5	10.21
7	0:01:23.5	10.21
8	0:01:27.5	10.22
9	0:01:31.5	10.23
10	0:01:35.5	10.23
11	0:01:39.5	10.24
12	0:01:43.5	10.24
13	0:01:47.5	10.25
14	0:01:51.5	10.26
15	0:01:55.5	10.26
16	0:01:59.5	10.27
17	0:02:03.5	10.27
18	0:02:07.5	10.28
19	0:02:11.5	10.28
20	0:02:15.5	10.28
21	0:02:19.5	10.29
22	0:02:23.5	10.29
23	0:02:27.5	10.30
24	0:02:31.5	10.30
25	0:02:35.5	10.31
26	0:02:39.5	10.31
27	0:02:43.5	10.31
28	0:02:47.5	10.32
29	0:02:51.5	10.32
30	0:02:55.5	10.33
31	0:02:59.5	10.33
32	0:03:03.5	10.33
33	0:03:07.5	10.34
34	0:03:11.5	10.34
35	0:03:15.5	10.34
36	0:03:19.5	10.35
37	0:03:23.5	10.35
38	0:03:27.5	10.36
39	0:03:31.5	10.36
40	0:03:35.5	10.36
41	0:03:39.5	10.37
42	0:03:43.5	10.37
43	0:03:47.5	10.37
44	0:03:51.5	10.38
45	0:03:55.5	10.38

WELL ID: Rio Dell Texaco

Local ID: MW-4, Run 1

Date: 1/6/2006

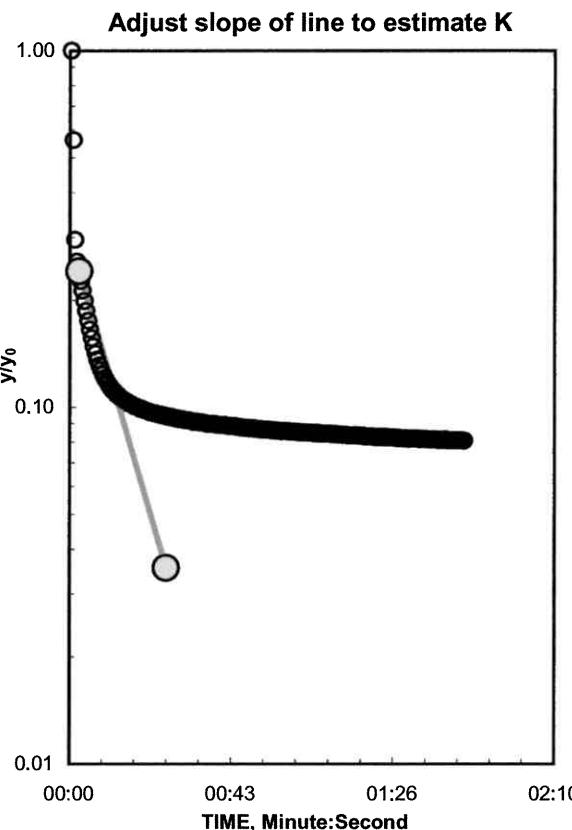
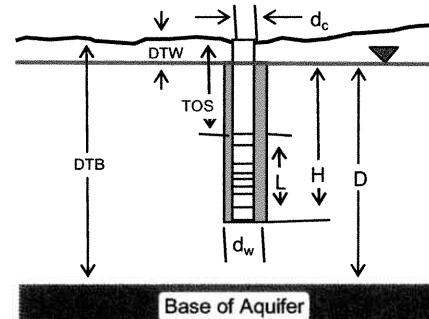
Time: 0:00

INPUT	
Construction:	
Casing dia. (d_c)	2 Inch
Annulus dia. (d_w)	8.25 Inch
Screen Length (L)	10 Feet
Depths to:	
water level (DTW)	8.6 Feet
top of screen (TOS)	5 Feet
Base of Aquifer (DTB)	25 Feet
Annular Fill:	
across screen --	Medium Sand
above screen --	Bentonite
Aquifer Material -- Fine Sand	

COMPUTED	
L_{wetted}	6.4 Feet
D	16.4 Feet
H	6.4 Feet
L/r_w	18.62
y_0 -DISPLACEMENT	5.71 Feet
y_0 -SLUG	4.69 Feet
From look-up table using L/r_w	
Partial penetrate A	2.160
B	0.335
$\ln(Re/rw)$	1.809
Re	2.10 Feet
Slope =	$0.035665 \log_{10}/sec$
$t_{90\%}$ recovery =	28 sec

Input is consistent.

K =	7 Feet/Day
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REMARKS:

Bouwer and Rice analysis of slug test, WRR 1976

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Reduced Data		
	Time, Hr:Min:Sec	Water Level
Entry		
1	0:00:06.5	0.05
2	0:00:08.5	4.37
3	0:00:10.5	4.70
4	0:00:12.5	4.91
5	0:00:14.5	5.03
6	0:00:16.5	5.10
7	0:00:18.5	5.14
8	0:00:20.5	5.16
9	0:00:22.5	5.18
10	0:00:24.5	5.19
11	0:00:26.5	5.20
12	0:00:28.5	5.21
13	0:00:30.5	5.22
14	0:00:32.5	5.22
15	0:00:34.5	5.23
16	0:00:36.5	5.23
17	0:00:38.5	5.24
18	0:00:40.5	5.24
19	0:00:42.5	5.25
20	0:00:44.5	5.25
21	0:00:46.5	5.25
22	0:00:48.5	5.25
23	0:00:50.5	5.26
24	0:00:52.5	5.26
25	0:00:54.5	5.26
26	0:00:56.5	5.26
27	0:00:58.5	5.27
28	0:01:00.5	5.27
29	0:01:02.5	5.27
30	0:01:04.5	5.27
31	0:01:06.5	5.27
32	0:01:08.5	5.28
33	0:01:10.5	5.28
34	0:01:12.5	5.28
35	0:01:14.5	5.28
36	0:01:16.5	5.28
37	0:01:18.5	5.28
38	0:01:20.5	5.28
39	0:01:22.5	5.28
40	0:01:24.5	5.29
41	0:01:26.5	5.29
42	0:01:28.5	5.29
43	0:01:30.5	5.29
44	0:01:32.5	5.29
45	0:01:34.5	5.29

WELL ID: Rio Dell Texaco

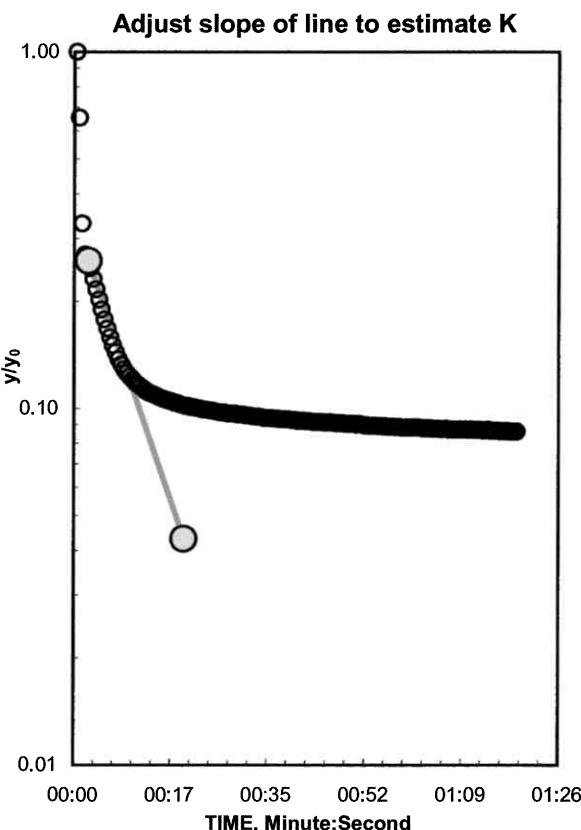
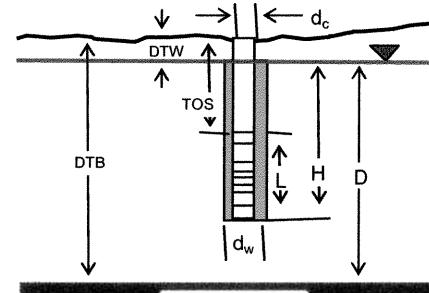
Local ID: MW-4, Run 3

Date: 1/6/2006

Time: 0:01

INPUT	
Construction:	
Casing dia. (d_c)	2 Inch
Annulus dia. (d_w)	8.25 Inch
Screen Length (L)	10 Feet
Depths to:	
water level (DTW)	8.6 Feet
top of screen (TOS)	5 Feet
Base of Aquifer (DTB)	25 Feet
Annular Fill:	
across screen --	Medium Sand
above screen --	Bentonite
Aquifer Material -- Fine Sand	

COMPUTED	
L_{wetted}	6.4 Feet
D =	16.4 Feet
H =	6.4 Feet
L/r_w =	18.62
y_0 -DISPLACEMENT =	5.17 Feet
y_0 -SLUG =	4.69 Feet
From look-up table using L/r_w	
Partial penetrate A =	2.160
B =	0.335
$\ln(Re/rw)$ =	1.809
Re =	2.10 Feet
Slope =	0.045595 \log_{10}/sec
$t_{90\%}$ recovery =	22 sec
Input is consistent.	
K =	8.9 Feet/Day



REMARKS:

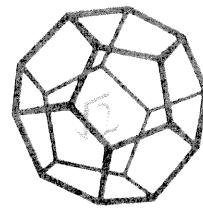
Bouwer and Rice analysis of slug test, WRR 1976

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Reduced Data		
	Time, Hr:Min:Sec	Water Level
1	0:01:41.5	0.72
2	0:01:43.0	4.49
3	0:01:44.5	4.70
4	0:01:46.0	4.91
5	0:01:47.5	5.07
6	0:01:49.0	5.18
7	0:01:50.5	5.24
8	0:01:52.0	5.28
9	0:01:53.5	5.30
10	0:01:55.0	5.32
11	0:01:56.5	5.34
12	0:01:58.0	5.35
13	0:01:59.5	5.36
14	0:02:01.0	5.36
15	0:02:02.5	5.37
16	0:02:04.0	5.38
17	0:02:05.5	5.38
18	0:02:07.0	5.39
19	0:02:08.5	5.39
20	0:02:10.0	5.39
21	0:02:11.5	5.39
22	0:02:13.0	5.40
23	0:02:14.5	5.40
24	0:02:16.0	5.40
25	0:02:17.5	5.41
26	0:02:19.0	5.41
27	0:02:20.5	5.41
28	0:02:22.0	5.41
29	0:02:23.5	5.42
30	0:02:25.0	5.42
31	0:02:26.5	5.42
32	0:02:28.0	5.42
33	0:02:29.5	5.42
34	0:02:31.0	5.42
35	0:02:32.5	5.42
36	0:02:34.0	5.43
37	0:02:35.5	5.43
38	0:02:37.0	5.43
39	0:02:38.5	5.43
40	0:02:40.0	5.43
41	0:02:41.5	5.43
42	0:02:43.0	5.43
43	0:02:44.5	5.44
44	0:02:46.0	5.44
45	0:02:47.5	5.44

Appendix D
Laboratory Analytical Reports

REC'D OCT 21 2005



NORTH COAST
LABORATORIES LTD.

October 20, 2005

SHN Consulting Engineers and Geologists
812 West Wabash Avenue
Eureka, CA 95501

Attn: Roland Rueber

RE: 004323, RIO DELL TEXACO

Order No.: 0510078
Invoice No.: 53667
PO No.:
ELAP No. 1247-Expires July 2006

SAMPLE IDENTIFICATION

Fraction Client Sample Description

01A	B-101 @ 6'
02A	B-101 @ 11.5'
03A	B-102 @ 6.5'
04A	B-103 @ 7.5'
05A	B-105 @ 15'
06A	B-104 @ 16.5'
07A	B-101
07C	B-101
08A	B-105
08C	B-105
09A	B-104
09C	B-104

ND = Not Detected at the Reporting Limit

Limit = Reporting Limit

All solid results are expressed on a wet-weight basis unless otherwise noted.

REPORT CERTIFIED BY

Jesse G. Chaney, Jr.
Laboratory Director

North Coast Laboratories, Ltd.

Date: 20-Oct-05

CLIENT: SHN Consulting Engineers and Geologists
Project: 004323, RIO DELL TEXACO
Lab Order: 0510078

CASE NARRATIVE

TPH as Diesel - Soil:

Samples B-101 @ 6', B-102 @ 6.5' and B-103 @ 7.5' contain some material lighter than diesel. However, some of this material extends into the diesel range of molecular weights.

Samples B-102 @ 6.5' and B-103 @ 7.5' contain material similar to degraded or weathered diesel oil.

Sample B-101 @ 6' contains material in the diesel range of molecular weights, but the material does not exhibit the peak pattern typical of diesel oil.

Due to an apparent laboratory error, sample B-101 @ 6' was not fortified with the surrogate standard..

TPH as Diesel - Water:

Sample B-101 contains some material lighter than diesel. However, some of this material extends into the diesel range of molecular weights.

Samples B-101 and B-104 contain material in the diesel range of molecular weights, but the material does not exhibit the peak pattern typical of diesel oil.

Samples B-101 and B-104 contain material in the diesel range of molecular weights and beyond. This suggests the presence of an oil heavier than diesel.

The surrogate for sample B-101 could not be quantified due to matrix interference.

The laboratory control sample duplicate (LCSD) recovery was slightly above the upper acceptance limit for diesel. The laboratory control sample (LCS) recovery was within the acceptance limits; therefore, the data were accepted.

Gasoline Components/Additives - Soil:

Sample B-101 @ 6' does not present a peak pattern consistent with that of gasoline. The reported result represents the amount of material in the gasoline range.

Samples B-102 @ 6.5' and B-103 @ 7.5' appear to be similar to gasoline but certain peak ratios are not that of a fresh gasoline standard. The reported results represent the amount of material in the gasoline range.

Some reporting limits were raised for samples B-102 @ 6.5' and B-103 @ 7.5' due to matrix interference.

Gasoline Components/Additives - Water:

CLIENT: SHN Consulting Engineers and Geologists
Project: 004323, RIO DELL TEXACO
Lab Order: 0510078

CASE NARRATIVE

The gasoline value for sample B-101 includes the reported gasoline components and additives in addition to other peaks in the gasoline range.

The gasoline values for samples B-105 and B-104 are primarily from the reported gasoline additives.

Sample B-101 was diluted and the reporting limit was raised additionally for MTBE due to matrix interference.

Date: 20-Oct-05
WorkOrder: 0510078

ANALYTICAL REPORT

Client Sample ID: B-101 @ 6'
Lab ID: 0510078-01A

Received: 10/5/05

Collected: 10/4/05 8:30

Test Name: Gasoline Components/Additives

Reference: LUFT/EPA 8260B Modified

Parameter	Result	Limit	Units	DF	Extracted	Analyzed
Methyl tert-butyl ether (MTBE)	ND	0.025	µg/g	1.0	10/12/05	10/13/05
Tert-butyl alcohol (TBA)	ND	0.50	µg/g	1.0	10/12/05	10/13/05
Di-isopropyl ether (DIPE)	ND	0.020	µg/g	1.0	10/12/05	10/13/05
Ethyl tert-butyl ether (ETBE)	ND	0.020	µg/g	1.0	10/12/05	10/13/05
Benzene	0.0058	0.0050	µg/g	1.0	10/12/05	10/13/05
Tert-amyl methyl ether (TAME)	ND	0.020	µg/g	1.0	10/12/05	10/13/05
Toluene	0.012	0.0050	µg/g	1.0	10/12/05	10/13/05
Ethylbenzene	0.13	0.0050	µg/g	1.0	10/12/05	10/13/05
m,p-Xylene	0.021	0.010	µg/g	1.0	10/12/05	10/13/05
o-Xylene	0.010	0.0050	µg/g	1.0	10/12/05	10/13/05
Surrogate: 1,4-Dichlorobenzene-d4	108	80-120	% Rec	1.0	10/12/05	10/13/05

Test Name: TPH as Diesel

Reference: EPA 3550/GCFID(LUFT)/EPA 8015B

Parameter	Result	Limit	Units	DF	Extracted	Analyzed
TPHC Diesel (C12-C22)	6.4	1.0	µg/g	1.0	10/17/05	10/19/05
Surrogate: N-Tricosane	0	55.4-126	% Rec	1.0	10/17/05	10/19/05

Test Name: TPH as Gasoline

Reference: LUFT/EPA 8260B Modified

Parameter	Result	Limit	Units	DF	Extracted	Analyzed
TPHC Gasoline	120	10	µg/g	10	10/12/05	10/14/05

Client Sample ID: B-101 @ 11.5'

Received: 10/5/05

Collected: 10/4/05 8:35

Lab ID: 0510078-02A

Test Name: Gasoline Components/Additives

Reference: LUFT/EPA 8260B Modified

Parameter	Result	Limit	Units	DF	Extracted	Analyzed
Methyl tert-butyl ether (MTBE)	0.027	0.025	µg/g	1.0	10/12/05	10/13/05
Tert-butyl alcohol (TBA)	ND	0.50	µg/g	1.0	10/12/05	10/13/05
Di-isopropyl ether (DIPE)	ND	0.020	µg/g	1.0	10/12/05	10/13/05
Ethyl tert-butyl ether (ETBE)	ND	0.020	µg/g	1.0	10/12/05	10/13/05
Benzene	ND	0.0050	µg/g	1.0	10/12/05	10/13/05
Tert-amyl methyl ether (TAME)	ND	0.020	µg/g	1.0	10/12/05	10/13/05
Toluene	ND	0.0050	µg/g	1.0	10/12/05	10/13/05
Ethylbenzene	ND	0.0050	µg/g	1.0	10/12/05	10/13/05
m,p-Xylene	ND	0.010	µg/g	1.0	10/12/05	10/13/05
o-Xylene	ND	0.0050	µg/g	1.0	10/12/05	10/13/05
Surrogate: 1,4-Dichlorobenzene-d4	109	80-120	% Rec	1.0	10/12/05	10/13/05

Test Name: TPH as Diesel

Reference: EPA 3550/GCFID(LUFT)/EPA 8015B

Parameter	Result	Limit	Units	DF	Extracted	Analyzed
Surrogate: 1,4-Dichlorobenzene-d4	109	80-120	% Rec	1.0	10/12/05	10/13/05

Date: 20-Oct-05

WorkOrder: 0510078

TPHC Diesel (C12-C22)	ND	1.0	µg/g	1.0	10/17/05	10/19/05
Surrogate: N-Tricosane	109	55.4-126	% Rec	1.0	10/17/05	10/19/05

Test Name: TPH as Gasoline

ANALYTICAL REPORT

Reference: LUFT/EPA 8260B Modified

Parameter	Result	Limit	Units	DF	Extracted	Analyzed
TPHC Gasoline	ND	1.0	µg/g	1.0	10/12/05	10/13/05

Client Sample ID: B-102 @ 6.5'

Received: 10/5/05

Collected: 10/4/05 9:30

Lab ID: 0510078-03A

Test Name: Gasoline Components/Additives

Reference: LUFT/EPA 8260B Modified

Parameter	Result	Limit	Units	DF	Extracted	Analyzed
Methyl tert-butyl ether (MTBE)	ND	0.085	µg/g	1.0	10/12/05	10/13/05
Tert-butyl alcohol (TBA)	ND	0.50	µg/g	1.0	10/12/05	10/13/05
Di-isopropyl ether (DIPE)	ND	0.020	µg/g	1.0	10/12/05	10/13/05
Ethyl tert-butyl ether (ETBE)	ND	0.020	µg/g	1.0	10/12/05	10/13/05
Benzene	0.038	0.0050	µg/g	1.0	10/12/05	10/13/05
Tert-amyl methyl ether (TAME)	ND	0.020	µg/g	1.0	10/12/05	10/13/05
Toluene	0.015	0.0050	µg/g	1.0	10/12/05	10/13/05
Ethylbenzene	1.2	0.0050	µg/g	1.0	10/12/05	10/13/05
m,p-Xylene	0.16	0.010	µg/g	1.0	10/12/05	10/13/05
o-Xylene	0.0097	0.0050	µg/g	1.0	10/12/05	10/13/05
Surrogate: 1,4-Dichlorobenzene-d4	105	80-120	% Rec	1.0	10/12/05	10/13/05

Test Name: TPH as Diesel

Reference: EPA 3550/GCFID(LUFT)/EPA 8015B

Parameter	Result	Limit	Units	DF	Extracted	Analyzed
TPHC Diesel (C12-C22)	44	1.0	µg/g	1.0	10/17/05	10/19/05
Surrogate: N-Tricosane	96.2	55.4-126	% Rec	1.0	10/17/05	10/19/05

Test Name: TPH as Gasoline

Reference: LUFT/EPA 8260B Modified

Parameter	Result	Limit	Units	DF	Extracted	Analyzed
TPHC Gasoline	100	10	µg/g	10	10/12/05	10/14/05

Date: 20-Oct-05
WorkOrder: 0510078

ANALYTICAL REPORT

Client Sample ID: B-103 @ 7.5'
Lab ID: 0510078-04A

Received: 10/5/05

Collected: 10/4/05 10:20

Test Name: Gasoline Components/Additives

Reference: LUFT/EPA 8260B Modified

Parameter	Result	Limit	Units	DF	Extracted	Analyzed
Methyl tert-butyl ether (MTBE)	ND	0.067	µg/g	1.0	10/12/05	10/13/05
Tert-butyl alcohol (TBA)	ND	0.50	µg/g	1.0	10/12/05	10/13/05
Di-isopropyl ether (DIPE)	ND	0.020	µg/g	1.0	10/12/05	10/13/05
Ethyl tert-butyl ether (ETBE)	ND	0.020	µg/g	1.0	10/12/05	10/13/05
Benzene	ND	0.0050	µg/g	1.0	10/12/05	10/13/05
Tert-amyl methyl ether (TAME)	ND	0.020	µg/g	1.0	10/12/05	10/13/05
Toluene	ND	0.013	µg/g	1.0	10/12/05	10/13/05
Ethylbenzene	0.14	0.0050	µg/g	1.0	10/12/05	10/13/05
m,p-Xylene	ND	0.020	µg/g	1.0	10/12/05	10/13/05
o-Xylene	ND	0.0050	µg/g	1.0	10/12/05	10/13/05
Surrogate: 1,4-Dichlorobenzene-d4	106	80-120	% Rec	1.0	10/12/05	10/13/05

Test Name: TPH as Diesel

Reference: EPA 3550/GCFID(LUFT)/EPA 8015B

Parameter	Result	Limit	Units	DF	Extracted	Analyzed
TPHC Diesel (C12-C22)	190	100	µg/g	100	10/17/05	10/19/05
Surrogate: N-Tricosane	93.6	55.4-126	% Rec	1.0	10/17/05	10/19/05

Test Name: TPH as Gasoline

Reference: LUFT/EPA 8260B Modified

Parameter	Result	Limit	Units	DF	Extracted	Analyzed
TPHC Gasoline	90	1.0	µg/g	1.0	10/12/05	10/13/05

Client Sample ID: B-105 @ 15'

Received: 10/5/05

Collected: 10/4/05 11:30

Lab ID: 0510078-05A

Test Name: Gasoline Components/Additives

Reference: LUFT/EPA 8260B Modified

Parameter	Result	Limit	Units	DF	Extracted	Analyzed
Methyl tert-butyl ether (MTBE)	ND	0.025	µg/g	1.0	10/12/05	10/13/05
Tert-butyl alcohol (TBA)	ND	0.50	µg/g	1.0	10/12/05	10/13/05
Di-isopropyl ether (DIPE)	ND	0.020	µg/g	1.0	10/12/05	10/13/05
Ethyl tert-butyl ether (ETBE)	ND	0.020	µg/g	1.0	10/12/05	10/13/05
Benzene	ND	0.0050	µg/g	1.0	10/12/05	10/13/05
Tert-amyl methyl ether (TAME)	ND	0.020	µg/g	1.0	10/12/05	10/13/05
Toluene	ND	0.0050	µg/g	1.0	10/12/05	10/13/05
Ethylbenzene	ND	0.0050	µg/g	1.0	10/12/05	10/13/05
m,p-Xylene	ND	0.010	µg/g	1.0	10/12/05	10/13/05
o-Xylene	ND	0.0050	µg/g	1.0	10/12/05	10/13/05
Surrogate: 1,4-Dichlorobenzene-d4	113	80-120	% Rec	1.0	10/12/05	10/13/05

Test Name: TPH as Diesel

Reference: EPA 3550/GCFID(LUFT)/EPA 8015B

Parameter	Result	Limit	Units	DF	Extracted	Analyzed

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Date: 20-Oct-05
WorkOrder: 0510078

ANALYTICAL REPORT

TPHC Diesel (C12-C22)	ND	1.0	µg/g	1.0	10/17/05	10/19/05
Surrogate: N-Tricosane	102	55.4-126	% Rec	1.0	10/17/05	10/19/05

Test Name: TPH as Gasoline

Reference: LUFT/EPA 8260B Modified

Parameter	Result	Limit	Units	DF	Extracted	Analyzed
TPHC Gasoline	ND	1.0	µg/g	1.0	10/12/05	10/14/05

Client Sample ID: B-104 @ 16.5'

Received: 10/5/05

Collected: 10/4/05 13:25

Lab ID: 0510078-06A

Test Name: Gasoline Components/Additives

Reference: LUFT/EPA 8260B Modified

Parameter	Result	Limit	Units	DF	Extracted	Analyzed
Methyl tert-butyl ether (MTBE)	ND	0.025	µg/g	1.0	10/12/05	10/13/05
Tert-butyl alcohol (TBA)	ND	0.50	µg/g	1.0	10/12/05	10/13/05
Di-isopropyl ether (DIPE)	ND	0.020	µg/g	1.0	10/12/05	10/13/05
Ethyl tert-butyl ether (ETBE)	ND	0.020	µg/g	1.0	10/12/05	10/13/05
Benzene	ND	0.0050	µg/g	1.0	10/12/05	10/13/05
Tert-amyl methyl ether (TAME)	ND	0.020	µg/g	1.0	10/12/05	10/13/05
Toluene	ND	0.0050	µg/g	1.0	10/12/05	10/13/05
Ethylbenzene	ND	0.0050	µg/g	1.0	10/12/05	10/13/05
m,p-Xylene	ND	0.010	µg/g	1.0	10/12/05	10/13/05
o-Xylene	ND	0.0050	µg/g	1.0	10/12/05	10/13/05
Surrogate: 1,4-Dichlorobenzene-d4	113	80-120	% Rec	1.0	10/12/05	10/13/05

Test Name: TPH as Diesel

Reference: EPA 3550/GCFID(LUFT)/EPA 8015B

Parameter	Result	Limit	Units	DF	Extracted	Analyzed
TPHC Diesel (C12-C22)	ND	1.0	µg/g	1.0	10/17/05	10/19/05
Surrogate: N-Tricosane	104	55.4-126	% Rec	1.0	10/17/05	10/19/05

Test Name: TPH as Gasoline

Reference: LUFT/EPA 8260B Modified

Parameter	Result	Limit	Units	DF	Extracted	Analyzed
TPHC Gasoline	ND	1.0	µg/g	1.0	10/12/05	10/13/05

Client Sample ID: B-101

Received: 10/5/05

Collected: 10/4/05 8:40

Lab ID: 0510078-07A

Test Name: TPH as Diesel

Reference: EPA 3510/GCFID(LUFT)/EPA 8015B

Parameter	Result	Limit	Units	DF	Extracted	Analyzed
TPHC Diesel (C12-C22)	3,400	50	µg/L	1.0	10/7/05	10/12/05
Surrogate: N-Tricosane	NQ	70-130	% Rec	1.0	10/7/05	10/12/05

Date: 20-Oct-05
WorkOrder: 0510078

ANALYTICAL REPORT

Client Sample ID: B-101
Lab ID: 0510078-07C

Received: 10/5/05

Collected: 10/4/05 8:40

Test Name: Gasoline Components/Additives

Reference: LUFT/EPA 8260B Modified

Parameter	Result	Limit	Units	DF	Extracted	Analyzed
Methyl tert-butyl ether (MTBE)	ND	500	µg/L	50		10/11/05
Tert-butyl alcohol (TBA)	ND	10	µg/L	1.0		10/12/05
Di-isopropyl ether (DIPE)	ND	1.0	µg/L	1.0		10/12/05
Ethyl tert-butyl ether (ETBE)	ND	1.0	µg/L	1.0		10/12/05
Benzene	20	0.50	µg/L	1.0		10/12/05
Tert-amyl methyl ether (TAME)	11	1.0	µg/L	1.0		10/12/05
Toluene	22	0.50	µg/L	1.0		10/12/05
Ethylbenzene	360	25	µg/L	50		10/11/05
m,p-Xylene	170	25	µg/L	50		10/11/05
o-Xylene	8.6	0.50	µg/L	1.0		10/12/05
Surrogate: 1,4-Dichlorobenzene-d4	103	80.8-139	% Rec	1.0		10/12/05

Test Name: TPH as Gasoline

Reference: LUFT/EPA 8260B Modified

Parameter	Result	Limit	Units	DF	Extracted	Analyzed
TPHC Gasoline	12,000	2,500	µg/L	50		10/11/05

Client Sample ID: B-105

Received: 10/5/05

Collected: 10/4/05 11:45

Lab ID: 0510078-08A

Test Name: TPH as Diesel

Reference: EPA 3510/GCFID(LUFT)/EPA 8015B

Parameter	Result	Limit	Units	DF	Extracted	Analyzed
TPHC Diesel (C12-C22)	ND	50	µg/L	1.0	10/7/05	10/12/05
Surrogate: N-Tricosane	109	70-130	% Rec	1.0	10/7/05	10/12/05

Date: 20-Oct-05
WorkOrder: 0510078

ANALYTICAL REPORT

Client Sample ID: B-105
Lab ID: 0510078-08C

Received: 10/5/05

Collected: 10/4/05 11:45

Test Name: Gasoline Components/Additives

Reference: LUFT/EPA 8260B Modified

Parameter	Result	Limit	Units	DF	Extracted	Analyzed
Methyl tert-butyl ether (MTBE)	97	50	µg/L	50		10/11/05
Tert-butyl alcohol (TBA)	ND	10	µg/L	1.0		10/12/05
Di-isopropyl ether (DIPE)	ND	1.0	µg/L	1.0		10/12/05
Ethyl tert-butyl ether (ETBE)	ND	1.0	µg/L	1.0		10/12/05
Benzene	ND	0.50	µg/L	1.0		10/12/05
Tert-amyl methyl ether (TAME)	ND	1.0	µg/L	1.0		10/12/05
Toluene	ND	0.50	µg/L	1.0		10/12/05
Ethylbenzene	ND	0.50	µg/L	1.0		10/12/05
m,p-Xylene	ND	0.50	µg/L	1.0		10/12/05
o-Xylene	ND	0.50	µg/L	1.0		10/12/05
Surrogate: 1,4-Dichlorobenzene-d4	104	80.8-139	% Rec	1.0		10/12/05

Test Name: TPH as Gasoline

Reference: LUFT/EPA 8260B Modified

Parameter	Result	Limit	Units	DF	Extracted	Analyzed
TPHC Gasoline	150	50	µg/L	1.0		10/12/05

Client Sample ID: B-104

Received: 10/5/05

Collected: 10/4/05 13:45

Lab ID: 0510078-09A

Test Name: TPH as Diesel

Reference: EPA 3510/GCFID(LUFT)/EPA 8015B

Parameter	Result	Limit	Units	DF	Extracted	Analyzed
TPHC Diesel (C12-C22)	71	50	µg/L	1.0	10/7/05	10/12/05
Surrogate: N-Tricosane	104	70-130	% Rec	1.0	10/7/05	10/12/05

Date: 20-Oct-05
WorkOrder: 0510078

ANALYTICAL REPORT

Client Sample ID: B-104
Lab ID: 0510078-09C

Received: 10/5/05

Collected: 10/4/05 13:45

Test Name: Gasoline Components/Additives

Reference: LUFT/EPA 8260B Modified

Parameter	Result	Limit	Units	DF	Extracted	Analyzed
Methyl tert-butyl ether (MTBE)	120	50	µg/L	50		10/11/05
Tert-butyl alcohol (TBA)	ND	10	µg/L	1.0		10/12/05
Di-isopropyl ether (DIPE)	ND	1.0	µg/L	1.0		10/12/05
Ethyl tert-butyl ether (ETBE)	ND	1.0	µg/L	1.0		10/12/05
Benzene	ND	0.50	µg/L	1.0		10/12/05
Tert-amyl methyl ether (TAME)	4.8	1.0	µg/L	1.0		10/12/05
Toluene	ND	0.50	µg/L	1.0		10/12/05
Ethylbenzene	ND	0.50	µg/L	1.0		10/12/05
m,p-Xylene	ND	0.50	µg/L	1.0		10/12/05
o-Xylene	ND	0.50	µg/L	1.0		10/12/05
Surrogate: 1,4-Dichlorobenzene-d4	107	80.8-139	% Rec	1.0		10/12/05

Test Name: TPH as Gasoline

Reference: LUFT/EPA 8260B Modified

Parameter	Result	Limit	Units	DF	Extracted	Analyzed
TPHC Gasoline	160	50	µg/L	1.0		10/12/05

North Coast Laboratories, Ltd.

Date: 20-Oct-05

CLIENT: SHN Consulting Engineers and Geologists

Work Order: 0510078

Project: 004323, RIO DELL TEXACO

QC SUMMARY REPORT

Method Blank

Sample ID	Batch ID:	Test Code:	Units:	Analysis Date	Prep Date					
Client ID:		Run ID:	µg/g	10/13/05 4:22:00 AM	10/12/05					
Analyte	Result	Limit	SPK value	% Rec	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Methyl tert-butyl ether (MTBE)	ND	0.025								
Ter-butyl alcohol (TBA)	ND	0.50								
Di-isopropyl ether (DIPE)	ND	0.020								
Ethyl tert-butyl ether (ETBE)	ND	0.020								J
Benzene	0.001328	0.0050								
Tert-amy methyl ether (TAME)	ND	0.020								
Toluene	0.002386	0.0050								J
Ethylbenzene	0.001490	0.0050								J
m,p-Xylene	ND	0.010								
o-Xylene	0.001488	0.0050								J
1,4-Dichlorobenzene-d4	1.02	0.10	1.00	0	102%	80	120	0	0	
Sample ID	Batch ID:	Test Code:	Units:	Analysis Date	Prep Date					
Client ID:		Run ID:	µg/L	10/11/05 6:41:00 AM						
Analyte	Result	Limit	SPK value	% Rec	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Methyl tert-butyl ether (MTBE)	ND	1.0								
Ter-butyl alcohol (TBA)	ND	10								
Di-isopropyl ether (DIPE)	ND	1.0								
Ethyl tert-butyl ether (ETBE)	ND	1.0								
Benzene	ND	0.50								
Tert-amy methyl ether (TAME)	ND	1.0								
Toluene	ND	0.50								
Ethylbenzene	0.08828	0.50								J
m,p-Xylene	0.1668	0.50								J
o-Xylene	ND	0.50								
1,4-Dichlorobenzene-d4	1.02	0.10	1.00	0	102%	81	139	0	0	

Qualifiers:

ND - Not Detected at the Reporting Limit

J - Analyte detected below quantitation limits

S - Spike Recovery outside accepted recovery limits

B - Analyte detected in the associated Method Blank

R - RPD outside accepted recovery limits

CLIENT: SHN Consulting Engineers and Geologists
Work Order: 0510078
Project: 004323, RIO DELL TEXACO

QC SUMMARY REPORT

Method Blank

Sample ID	MB-14408	Batch ID:	14408	Test Code:	GAAS-MS	Units:	µg/g	Analysis Date	10/13/05 4:22:00 AM	Prep Date	10/12/05	
Client ID:		Run ID:	ORGCMSS2_051013A	SeqNo:	538913							
Analyte		Result	Limit	SPK value	SPK Ref Val	% Rec	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
TPHC Gasoline		ND	1.0									

Sample ID	MB-14408A	Batch ID:	14408	Test Code:	GAAS-MS	Units:	µg/g	Analysis Date	10/14/05 7:26:00 AM	Prep Date	10/12/05	
Client ID:		Run ID:	ORGCMSS2_051013B	SeqNo:	538978							
Analyte		Result	Limit	SPK value	SPK Ref Val	% Rec	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
TPHC Gasoline		ND	1.0									

Sample ID	MB-101105	Batch ID:	R37381	Test Code:	GASW-MS	Units:	µg/L	Analysis Date	10/11/05 6:41:00 AM	Prep Date		
Client ID:		Run ID:	ORGCMSS3_051011A	SeqNo:	538054							
Analyte		Result	Limit	SPK value	SPK Ref Val	% Rec	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
TPHC Gasoline		26.25	50									J

Sample ID	MB-14431	Batch ID:	14431	Test Code:	TPHDIS	Units:	µg/g	Analysis Date	10/19/05 2:20:16 AM	Prep Date		
Client ID:		Run ID:	ORGCT_051018B	SeqNo:	540210							
Analyte		Result	Limit	SPK value	SPK Ref Val	% Rec	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
TPHC Diesel (C12-C22)		ND	1.0									

Sample ID	MB-14374	Batch ID:	14374	Test Code:	TPHDW	Units:	µg/L	Analysis Date	10/11/05 10:41:46 PM	Prep Date		
Client ID:		Run ID:	ORGCT_051011A	SeqNo:	537976							
Analyte		Result	Limit	SPK value	SPK Ref Val	% Rec	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
TPHC Diesel (C12-C22)		ND	50									

Qualifiers: ND - Not Detected at the Reporting Limit

J - Analyte detected below quantitation limits

S - Spike Recovery outside accepted recovery limits

R - RPD outside accepted recovery limits

B - Analyte detected in the associated Method Blank

North Coast Laboratories, Ltd.

Date: 20-Oct-05

CLIENT: SHN Consulting Engineers and Geologists

Work Order: 0510078

Project: 004323, RIO DELL TEXACO

QC SUMMARY REPORT

Laboratory Control Spike

Sample ID	Batch ID:	Test Code:	Run ID:	Units:	Analysis Date	Prep Date					
Client ID:		8260OXYS	ORGCMS2_051013C	µg/g	10/13/05 12:15:00 PM	10/12/05					
Analyte	Result	Limit	SPK value	SPK Ref Val	% Rec	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Methyl tert-butyl ether (MTBE)	0.3792	0.025	0.400	0	94.8%	86	137	0	0		
Tert-butyl alcohol (TBA)	9.185	0.50	8.00	0	115%	43	185	0	0		
Di-isopropyl ether (DIPE)	0.3811	0.020	0.400	0	95.3%	80	137	0	0		
Ethyl tert-butyl ether (ETBE)	0.3725	0.020	0.400	0	93.1%	81	133	0	0		
Benzene	0.4243	0.0050	0.400	0	106%	74	137	0	0		
Tert-amyl methyl ether (TAME)	0.3599	0.020	0.400	0	90.0%	81	135	0	0		
Toluene	0.3995	0.0050	0.400	0	99.9%	69	139	0	0		
Ethylbenzene	0.3993	0.0050	0.400	0	99.8%	77	139	0	0		
m,p-Xylene	0.8920	0.010	0.800	0	111%	74	147	0	0		
o-Xylene	0.3662	0.0050	0.400	0	91.6%	62	147	0	0		
1,4-Dichlorobenzene-d4	1.20	0.10	1.00	0	120%	80	120	0	0		
Sample ID	Batch ID:	Test Code:	Run ID:	Units:	Analysis Date	Prep Date					
Client ID:		8260OXYS	ORGCMS2_051013C	µg/g	10/13/05 12:46:00 PM	10/12/05					
Analyte	Result	Limit	SPK value	SPK Ref Val	% Rec	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Methyl tert-butyl ether (MTBE)	0.3934	0.025	0.400	0	98.4%	86	137	0.379	3.68%	20	
Tert-butyl alcohol (TBA)	9.433	0.50	8.00	0	118%	43	185	9.18	2.67%	20	
Di-isopropyl ether (DIPE)	0.3946	0.020	0.400	0	98.6%	80	137	0.381	3.47%	20	
Ethyl tert-butyl ether (ETBE)	0.3875	0.020	0.400	0	96.9%	81	133	0.372	3.93%	20	
Benzene	0.4263	0.0050	0.400	0	107%	74	137	0.424	0.451%	20	
Tert-amyl methyl ether (TAME)	0.3767	0.020	0.400	0	94.2%	81	135	0.360	4.55%	20	
Toluene	0.4169	0.0050	0.400	0	104%	69	139	0.400	4.24%	20	
Ethylbenzene	0.4113	0.0050	0.400	0	103%	77	139	0.399	2.94%	20	
m,p-Xylene	0.8939	0.010	0.800	0	112%	74	147	0.892	0.215%	20	
o-Xylene	0.3773	0.0050	0.400	0	94.3%	62	147	0.366	2.99%	20	
1,4-Dichlorobenzene-d4	1.20	0.10	1.00	0	120%	80	120	1.20	0.284%	15	

Qualifiers: ND - Not Detected at the Reporting Limit
I - Analyte detected below quantitation limits

S - Spike Recovery outside accepted recovery limits
R - RPD outside accepted recovery limits

B - Analyte detected in the associated Method Blank

CLIENT: SHN Consulting Engineers and Geologists
Work Order: 0510078
Project: 004323, RIO DELL TEXACO

QC SUMMARY REPORT
Laboratory Control Spike

Sample ID	LCS-05652	Batch ID:	R37390	Test Code:	8260OXYW	Units:	µg/L	Analysis Date	10/11/05 4:59:00 AM	Prep Date		
Client ID:		Run ID:	ORGCMSS3_051011B					SeqNo:	538156			
Analyte		Result	Limit	SPK value	SPK Ref Val	% Rec	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Methyl tert-butyl ether (MTBE)	19.56	1.0	20.0	0	97.8%	80	120	120	0	0	0	
Tert-butyl alcohol (TBA)	399.2	10	400	0	99.8%	25	162	162	0	0	0	
Di-isopropyl ether (DIPE)	19.44	1.0	20.0	0	97.2%	80	120	120	0	0	0	
Ethyl tert-butyl ether (ETBE)	19.18	1.0	20.0	0	95.9%	77	120	120	0	0	0	
Benzene	20.03	0.50	20.0	0	100%	78	117	117	0	0	0	
Tert-amyl methyl ether (TAME)	19.06	1.0	20.0	0	95.3%	64	136	136	0	0	0	
Toluene	19.97	0.50	20.0	0	99.8%	80	120	120	0	0	0	
Ethylbenzene	18.93	0.50	20.0	0	94.6%	80	120	120	0	0	0	
m,p-Xylene	38.96	0.50	40.0	0	97.4%	80	120	120	0	0	0	
o-Xylene	18.61	0.50	20.0	0	93.0%	80	120	120	0	0	0	
1,4-Dichlorobenzene-d4	1.09	0.10	1.00	0	109%	81	139	139	0	0	0	
Sample ID	LCSD-05652	Batch ID:	R37390	Test Code:	8260OXYW	Units:	µg/L	Analysis Date	10/12/05 2:19:00 AM	Prep Date		
Client ID:		Run ID:	ORGCMSS3_051011B					SeqNo:	538167			
Analyte		Result	Limit	SPK value	SPK Ref Val	% Rec	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Methyl tert-butyl ether (MTBE)	19.07	1.0	20.0	0	95.3%	80	120	120	19.6	2.56%	20	
Tert-butyl alcohol (TBA)	383.8	10	400	0	95.9%	25	162	162	399	3.92%	20	
Di-isopropyl ether (DIPE)	19.32	1.0	20.0	0	96.6%	80	120	120	19.4	0.532%	20	
Ethyl tert-butyl ether (ETBE)	18.22	1.0	20.0	0	91.1%	77	120	120	19.2	5.14%	20	
Benzene	20.35	0.50	20.0	0	102%	78	117	117	20.0	1.60%	20	
Tert-amyl methyl ether (TAME)	17.93	1.0	20.0	0	89.6%	64	136	136	19.1	6.10%	20	
Toluene	20.86	0.50	20.0	0	104%	80	120	120	20.0	4.39%	20	
Ethylbenzene	19.63	0.50	20.0	0	98.2%	80	120	120	18.9	3.65%	20	
m,p-Xylene	40.42	0.50	40.0	0	101%	80	120	120	39.0	3.68%	20	
o-Xylene	18.20	0.50	20.0	0	91.0%	80	120	120	18.6	2.20%	20	
1,4-Dichlorobenzene-d4	1.12	0.10	1.00	0	112%	81	139	139	1.09	2.56%	20	

Qualifiers:

ND - Not Detected at the Reporting Limit

J - Analyte detected below quantitation limits

S - Spike Recovery outside accepted recovery limits

B - Analyte detected in the associated Method Blank

R - RPD outside accepted recovery limits

CLIENT: SHN Consulting Engineers and Geologists
Work Order: 0510078
Project: 004323, RIO DELL TEXACO

QC SUMMARY REPORT
Laboratory Control Spike

Sample ID	Batch ID:	Test Code:	Units:	% Rec	Analysis Date	Prep Date
LCSG-14408	14408	GASS-MS	µg/g		10/13/05 2:18:00 AM	10/12/05
Client ID:		Run ID:	ORGCMS2_051013A		SeqNo:	538910
Analyte		Result	Limit	SPK value	SPK Ref Val	LowLimit HighLimit RPD Ref Val %RPD RPD Limit Qual
TPHC Gasoline	17.94	1.0	20.0	0	89.7%	64 150 0
Sample ID	LCSDG-14408	Batch ID:	14408	Test Code:	GASS-MS	Analysis Date
Client ID:				Units:	µg/g	10/13/05 2:49:00 AM
Analyte		Result	Limit	SPK value	SPK Ref Val	SeqNo:
TPHC Gasoline	18.59	1.0	20.0	0	93.0%	64 150 17.9 3.55% 20
Sample ID	LCSG-14408A	Batch ID:	14408	Test Code:	GASS-MS	Analysis Date
Client ID:				Units:	µg/g	10/14/05 6:26:00 AM
Analyte		Result	Limit	SPK value	SPK Ref Val	SeqNo:
TPHC Gasoline	15.80	1.0	20.0	0	79.0%	64 150 0
Sample ID	LCS-05653	Batch ID:	R37381	Test Code:	GASW-MS	Analysis Date
Client ID:				Units:	µg/L	10/11/05 5:50:00 AM
Analyte		Result	Limit	SPK value	SPK Ref Val	SeqNo:
TPHC Gasoline	968.9	50	1,000	0	96.9%	80 120 0
Sample ID	LCSD-05653	Batch ID:	R37381	Test Code:	GASW-MS	Analysis Date
Client ID:				Units:	µg/L	10/12/05 2:45:00 AM
Analyte		Result	Limit	SPK value	SPK Ref Val	SeqNo:
TPHC Gasoline	930.8	50	1,000	0	93.1%	80 120 969 4.01% 20

Qualifiers: ND - Not Detected at the Reporting Limit
J - Analyte detected below quantitation limits
R - RPD outside accepted recovery limits

S - Spike Recovery outside accepted recovery limits
R - RPD outside accepted recovery limits

B - Analyte detected in the associated Method Blank

CLIENT: SHN Consulting Engineers and Geologists
Work Order: 0510078
Project: 004323, RIO DELL TEXACO

QC SUMMARY REPORT
Laboratory Control Spike

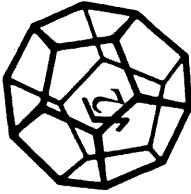
Sample ID	LCS-14431	Batch ID:	14431	Test Code:	TPHDI	Units:	µg/g	Analysis Date	10/19/05 12:19:11 AM	Prep Date	10/17/05			
Client ID:				Run ID:	ORGCT_051018B			SeqNo:	540207					
Analyte				Result	Limit	SPK value	SPK Ref Val	% Rec	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
TPHC Diesel (C12-C22)			10.85	1.0	10.0	0	109%	73	137	0				
N-Tricosane			1.23	0.10	1.00	0	123%	55	126	0				
Sample ID	LCSD-14431	Batch ID:	14431	Test Code:	TPHDI	Units:	µg/g	Analysis Date	10/19/05 12:39:02 AM	Prep Date	10/17/05			
Client ID:				Run ID:	ORGCT_051018B			SeqNo:	540208					
Analyte				Result	Limit	SPK value	SPK Ref Val	% Rec	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
TPHC Diesel (C12-C22)			11.39	1.0	10.0	0	114%	73	137	10.8	4.81%	15		
N-Tricosane			1.24	0.10	1.00	0	124%	55	126	1.23	1.10%	15		
Sample ID	LCS-14374	Batch ID:	14374	Test Code:	TPHDIW	Units:	µg/L	Analysis Date	10/11/05 8:40:57 PM	Prep Date	10/7/05			
Client ID:				Run ID:	ORGCT_051011A			SeqNo:	537973					
Analyte				Result	Limit	SPK value	SPK Ref Val	% Rec	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
TPHC Diesel (C12-C22)			569.7	50	500	0	114%	67	120	0				
N-Tricosane			61.2	0.10	50.0	0	122%	70	130	0				
Sample ID	LCSD-14374	Batch ID:	14374	Test Code:	TPHDIW	Units:	µg/L	Analysis Date	10/11/05 9:00:57 PM	Prep Date	10/7/05			
Client ID:				Run ID:	ORGCT_051011A			SeqNo:	537974					
Analyte				Result	Limit	SPK value	SPK Ref Val	% Rec	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
TPHC Diesel (C12-C22)			600.5	50	500	0	120%	67	120	570	5.26%	15		
N-Tricosane			63.5	0.10	50.0	0	127%	70	130	61.2	3.75%	15	S	

Qualifiers:

ND - Not Detected at the Reporting Limit
I - Analyte detected below quantitation limits

S - Spike Recovery outside accepted recovery limits
R - RPD outside accepted recovery limits

B - Analyte detected in the associated Method Blank



NORTH COAST LABORATORIES LTD.

6680 West End Road • Arcata • CA 95521-9202
707-822-4649 Fax 707-822-6831

Chain of Custody

Attention: Bonnie Busker

Results & Invoice to: SHN

Address: 812 West Wabash Avenue

Eureka, CA 95501

Phone: 441-8855

Copies of Report to: _____

Sampler (Sign & Print): John J. Goss

*MATRIX: DW=Drinking Water; Eff=Effluent; Inf=Influent; SW=Surface Water; GW=Ground Water; S=Soil; O=Other.

ALL CONTAMINATED NON-AQUEOUS SAMPLES WILL BE RETURNED TO CLIENT

REG'D NOV - 7 2005

**Laboratory Report for
SHN Consulting Engineers &
Geologists, Inc.**

Project No. 004323

November 2, 2005



Daniel B. Stephens & Associates, Inc.

6020 Academy NE, Suite 100 • Albuquerque, New Mexico 87109



November 2, 2005

Mr. Roland Rueber
SHN Consulting Engineers & Geologists, Inc.
812 W. Wabash
Eureka, CA 95501
(707) 441-8855

Re: DBS&A Laboratory Report for SHN Consulting Engineers & Geologists, Inc. (Project # 004323)

Dear Mr. Rueber:

Enclosed is the final report for the SHN Consulting Engineers & Geologists (Project # 004323) samples. Please review this report and provide any comments as samples will be held for a maximum of 30 days. After 30 days samples will be returned or disposed of in an appropriate manner.

All testing results were evaluated subjectively for consistency and reasonableness, and the results appear to be reasonably representative of the material tested. However, DBS&A does not assume any responsibility for interpretations or analyses based on the data enclosed, nor can we guarantee that these data are fully representative of the undisturbed materials at the field site. We recommend that careful evaluation of these laboratory results be made for your particular application.

The testing utilized to generate the enclosed final report employs methods that are standard for the industry. The results do not constitute a professional opinion by DBS&A, nor can the results affect any professional or expert opinions rendered with respect thereto by DBS&A. You have acknowledged that all the testing undertaken by us, and the final report provided, constitutes mere test results using standardized methods, and cannot be used to disqualify DBS&A from rendering any professional or expert opinion, having waived any claim of conflict of interest by DBS&A.

We are pleased to provide this service to SHN Consulting Engineers & Geologists, Inc. and look forward to future laboratory testing on other projects. If you have any questions about the enclosed data, please do not hesitate to call.

Sincerely,

DANIEL B. STEPHENS & ASSOCIATES, INC.
LABORATORY / TESTING FACILITY

A handwritten signature in black ink, appearing to read "Joleen Hines".

Joleen Hines
Laboratory Supervising Manager

Enclosure

Daniel B. Stephens & Associates, Inc.

6020 Academy NE, Suite 100

505-822-9400

Summaries



Daniel B. Stephens & Associates, Inc.

Summary of Tests Performed

Laboratory Sample Number	Initial Soil Properties ¹ (θ , ρ_d , ϕ)	Saturated Hydraulic Conductivity ²		Moisture Characteristics ³		Unsaturated Hydraulic Conductivity	Particle Size ⁴	Effective Porosity	Particle Density	FOC	1/3, 15 Bar Points and Water Holding Capacity	Atterberg Limits	Proctor Compaction
		CH	FH	HC	PP	TH	WP	RH					
B-102 @ 10'-11'	X								X	X	X		
B-103 @ 11.5'	X										X		

¹ θ = Initial moisture content, ρ_d = Dry bulk density, ϕ = Calculated porosity

² CH = Constant head, FH = falling head

³ HC = Hanging column, PP = Pressure plate, TH = Thermocouple psychrometer, WP = Water activity meter, RH = Relative humidity box

⁴ DS = Dry sieve, WS = Wet sieve, H = Hydrometer



**Summary of Initial Moisture Content, Dry Bulk Density
Wet Bulk Density and Calculated Porosity**

Sample Number	Initial Moisture Content		Dry Bulk Density (g/cm ³)	Wet Bulk Density (g/cm ³)	Calculated Porosity (%)
	Gravimetric (%, g/g)	Volumetric (%, cm ³ /cm ³)			
B-102 @ 10'-11'	21.9	36.5	1.66	2.03	37.2
B-103 @ 11.5'	15.1	27.1	1.79	2.06	32.4

NA = Not analyzed



Daniel B. Stephens & Associates, Inc.

Summary of Particle Size Characteristics

Sample Number	d_{10} (mm)	d_{50} (mm)	d_{60} (mm)	C_u	C_c	Method	ASTM Classification	USDA Classification	(Est)
B-102 @ 10'-11'	0.0010	0.017	0.025	25	1.7	WS/H	Classification by ASTM 2487 requires Atterberg test	Silt Loam	

d_{50} = Median particle diameter

Est = Reported values for d_{10} , C_u , C_c , and soil classification are estimates, since extrapolation was required to obtain the d_{10} diameter

DS = Dry sieve

H = Hydrometer

WS = Wet sieve

[†] Greater than 10% of sample is coarse material

$$C_u = \frac{d_{60}}{d_{10}}$$

$$C_c = \frac{(d_{30})^2}{(d_{10})(d_{60})}$$



Daniel B. Stephens & Associates, Inc.

Summary of Total Organic Carbon Tests

<u>Sample Number</u>	Fractional Organic Carbon (%)
B-102 @ 10'-11'	0.18
B-103 @ 11.5'	0.20

Comments: *ND-not detected at the reporting limit.

Laboratory Data and Graphical Plots

Initial Properties



Daniel B. Stephens & Associates, Inc.

**Summary of Initial Moisture Content, Dry Bulk Density
Wet Bulk Density and Calculated Porosity**

Sample Number	Initial Moisture Content		Dry Bulk Density (g/cm ³)	Wet Bulk Density (g/cm ³)	Calculated Porosity (%)
	Gravimetric (%, g/g)	Volumetric (%, cm ³ /cm ³)			
B-102 @ 10'-11'	21.9	36.5	1.66	2.03	37.2
B-103 @ 11.5'	15.1	27.1	1.79	2.06	32.4

NA = Not analyzed



Daniel B. Stephens & Associates, Inc.

Data for Initial Moisture Content, Bulk Density, Porosity, and Percent Saturation

Job Name: SHN Consulting

Job Number: LB05.0225.00

Sample Number: B-102 @ 10'-11'

Depth (ft): 10'-11'

Ring #: NA

Test Date: 11-Oct-05

Field weight of sample (g):* 134.34

Tare weight, ring (g): 0.00

Tare weight, cap/plate/epoxy (g): 13.96

Dry weight of sample (g): 98.73

Sample volume (cm³): 59.33

Assumed particle density: 2.65

Initial Volumetric Moisture Content (% vol): 36.5

Initial Gravimetric Moisture Content (% g/g): 21.9

Dry bulk density (g/cm³): 1.66

Wet bulk density (g/cm³): 2.03

Calculated Porosity (% vol): 37.2

Percent Saturation: 98.1

Comments:

* Weight including tares

NA = Not analyzed

Laboratory analysis by: D. O'Dowd

Data entered by: D. O'Dowd

Checked by: J. Hines



Daniel B. Stephens & Associates, Inc.

Data for Initial Moisture Content, Bulk Density, Porosity, and Percent Saturation

Job Name: SHN Consulting

Job Number: LB05.0225.00

Sample Number: B-103 @ 11.5'

Depth (ft): 11.5'

Ring #: NA

Test Date: 11-Oct-05

Field weight* of sample (g): 204.21

Tare weight, ring (g): 12.99

Tare weight, cap/plate/epoxy (g): 13.74

Dry weight of sample (g): 154.13

Sample volume (cm³): 86.01

Assumed particle density: 2.65

Initial Volumetric Moisture Content (% vol): 27.1

Initial Gravimetric Moisture Content (% g/g): 15.1

Dry bulk density (g/cm³): 1.79

Wet bulk density (g/cm³): 2.06

Calculated Porosity (% vol): 32.4

Percent Saturation: 83.8

Comments:

* Weight including tares

NA = Not analyzed

Laboratory analysis by: D. O'Dowd

Data entered by: D. O'Dowd

Checked by: J. Hines

Particle Size Analysis



Daniel B. Stephens & Associates, Inc.

Summary of Particle Size Characteristics

Sample Number	d_{10} (mm)	d_{50} (mm)	d_{60} (mm)	C_u	C_c	Method	ASTM Classification by ASTM 2487 requires Atterberg test	USDA Classification	(Est)
B-102 @ 10-11'	0.0010	0.017	0.025	25	1.7	WS/H	Classification by ASTM 2487 requires Atterberg test	Silt Loam	

d_{50} = Median particle diameter

Est = Reported values for d_{10} , C_u , C_c , and soil classification are estimates, since extrapolation was required to obtain the d_{10} diameter

DS = Dry sieve

H = Hydrometer

WS = Wet sieve

[†] Greater than 10% of sample is coarse material

$$C_u = \frac{d_{60}}{d_{10}}$$

$$C_c = \frac{(d_{30})^2}{(d_{10})(d_{60})}$$



Daniel B. Stephens & Associates, Inc.

Particle Size Analysis Wet Sieve Data (#10 Split)

Job Name: SHN Consulting **Initial Dry Weight of Sample (g):** 300.77
Job Number: LB05.0225.00 **Weight Passing #10 (g):** 300.77
Sample Number: B-102 @ 10'-11' **Weight Retained #10 (g):** 0.00
Depth (ft): 10'-11' **Weight of Hydrometer Sample (g):** 52.26
Ring #: NA **Calculated Weight of Sieve Sample (g):** 52.26

Test Date: 11-Oct-05

Shape: Rounded

Hardness: Soft

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10	3"	75	0.00	0.00	300.77	100.00
	2"	50	0.00	0.00	300.77	100.00
	1.5"	38.1	0.00	0.00	300.77	100.00
	1"	25	0.00	0.00	300.77	100.00
	3/4"	19.0	0.00	0.00	300.77	100.00
	3/8"	9.5	0.00	0.00	300.77	100.00
	4	4.75	0.00	0.00	300.77	100.00
	10	2.00	0.00	0.00	300.77	100.00
-10	(Based on calculated sieve wt.)					
	20	0.85	0.01	0.01	52.25	99.98
	40	0.425	0.02	0.03	52.23	99.94
	60	0.250	0.31	0.34	51.92	99.35
	140	0.106	4.70	5.04	47.22	90.36
	200	0.075	2.04	7.08	45.18	86.45
	dry pan		0.02	7.10	45.16	
	wet pan			45.16	0.00	

$$d_{10} \text{ (mm): } 0.0010 \qquad d_{50} \text{ (mm): } 0.017$$

$$d_{16} \text{ (mm): } 0.0020 \qquad d_{60} \text{ (mm): } 0.025$$

$$d_{30} \text{ (mm): } 0.0065 \qquad d_{84} \text{ (mm): } 0.068$$

$$\text{Median Particle Diameter--}d_{50} \text{ (mm): } 0.017$$

$$\text{Uniformity Coefficient, } C_u = [d_{60}/d_{10}] \text{ (mm): } 25$$

$$\text{Coefficient of Curvature, } C_c = [(d_{30})^2/(d_{10} * d_{60})] \text{ (mm): } 1.7$$

$$\text{Mean Particle Diameter--}[(d_{16} + d_{50} + d_{84})/3] \text{ (mm): } 0.029$$

Note: Reported values for d_{10} , C_u , C_c , and soil classification are estimates, since extrapolation was required to obtain the d_{10} diameter

ASTM Soil Classification: Classification by ASTM 2487 requires Atterberg test
USDA Soil Classification: Silt Loam

Laboratory analysis by: D. O'Dowd/T. Bowekaty

Data entered by: D. O'Dowd

Checked by: J. Hines



Daniel B. Stephens & Associates, Inc.

Particle Size Analysis Hydrometer Data

Job Name: SHN Consulting

Job Number: LB05.0225.00

Sample Number: B-102 @ 10'-11'

Depth (ft): 10'-11'

Ring #: NA

Test Date: 21-Oct-05

Start Time: 9:00

Type of Water Used: DISTILLED

Reaction with H₂O₂: NA

Dispersant*: (NaPO₃)₆

Assumed particle density: 2.65

Initial Wt. (g): 52.26

Total Sample Wt. (g): 300.77

Wt. Passing #10 (g): 300.77

Date	Time (min)	Temp (°C)	R (g/L)	R _L (g/L)	R _{corr} (g/L)	L (cm)	D (mm)	P (%)	% Finer
25-Oct-05	1	22.4	43.0	5.4	37.6	9.3	0.04026	71.9	71.9
	2	22.4	39.0	5.4	33.6	9.9	0.02946	64.3	64.3
	5	22.4	33.0	5.4	27.6	10.9	0.01953	52.8	52.8
	10	22.2	29.5	5.4	24.1	11.5	0.01420	46.1	46.1
	20	22.1	25.0	5.5	19.5	12.2	0.01037	37.3	37.3
	60	21.4	21.0	5.7	15.3	12.9	0.00620	29.3	29.3
	120	20.8	19.0	5.8	13.2	13.2	0.00447	25.3	25.3
	240	20.3	17.0	6.0	11.0	13.5	0.00322	21.0	21.0
	475	19.2	15.5	6.3	9.2	13.8	0.00234	17.6	17.6
	26-Oct-05	1415	19.2	13.0	6.3	6.7	0.00138	12.8	12.8

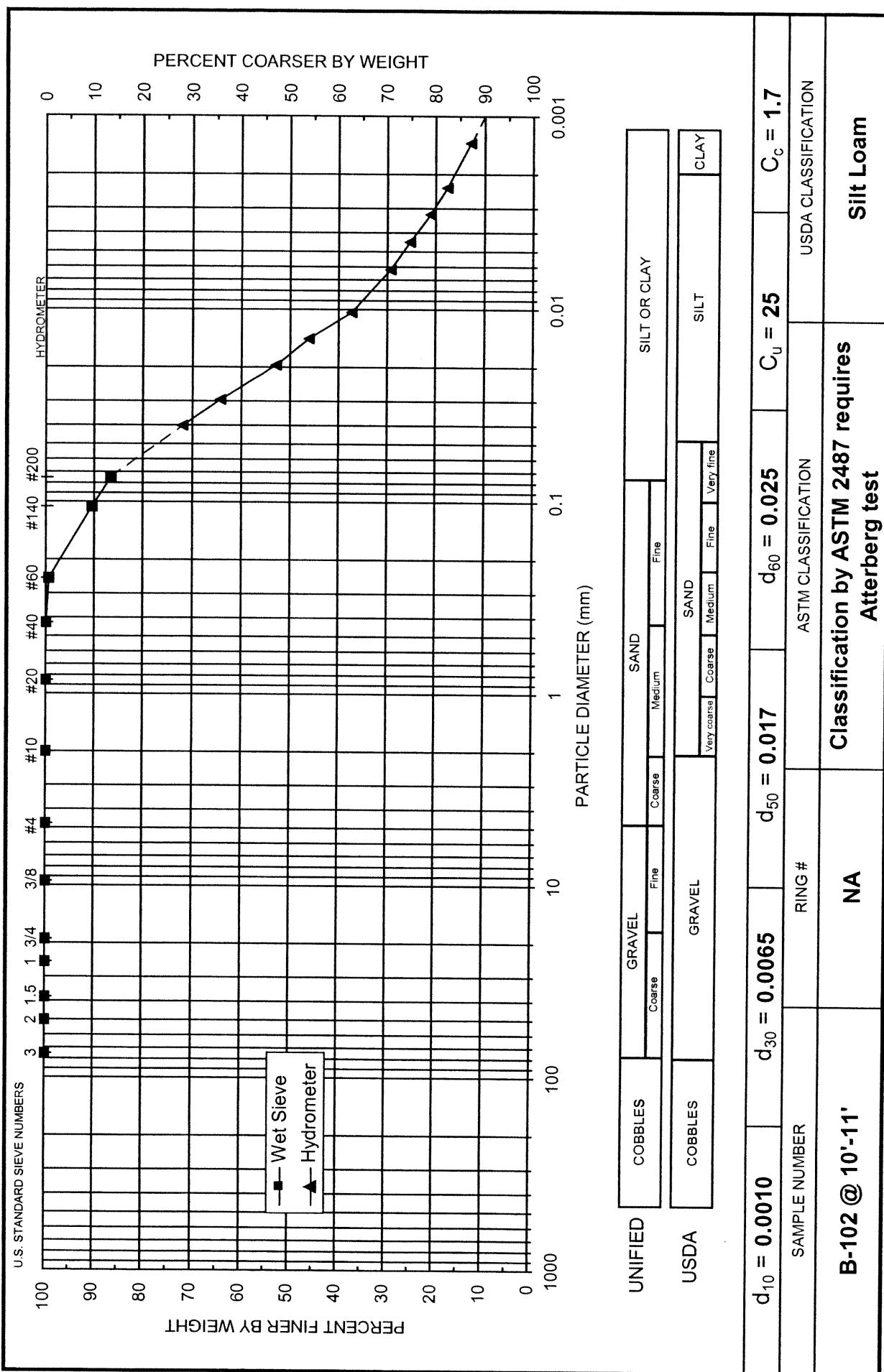
Comments:

* Dispersion device: mechanically operated stirring device

Laboratory analysis by: T. Bowekaty

Data entered by: D. O'Dowd

Checked by: J. Hines



Daniel B. Stephens & Associates, Inc.

Fractional Organic Carbon



Daniel B. Stephens & Associates, Inc.

Summary of Total Organic Carbon Tests

<u>Sample Number</u>	<u>Fractional Organic Carbon (%)</u>
B-102 @ 10'-11'	0.18
B-103 @ 11.5'	0.20

Comments: *ND-not detected at the reporting limit.

Hall Environmental Analysis Laboratory

Date: 14-Oct-05

CLIENT: Daniel B. Stephens & Assoc.
Project: DBS & A

Lab Order: 0510090

Lab ID: 0510090-01 Collection Date: 10/11/2005 11:05:00 AM

Client Sample ID: B-102 Matrix: SOIL

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed
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WALKLEY-BLACK METHOD: FOC

FOC	0.18	0.10	% C	1	10/13/2005	Analyst: MAP
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Lab ID: 0510090-02 Collection Date: 10/11/2005 11:15:00 AM

Client Sample ID: B-103 Matrix: SOIL

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed
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WALKLEY-BLACK METHOD: FOC

FOC	0.20	0.10	% C	1	10/13/2005	Analyst: MAP
-----	------	------	-----	---	------------	--------------

Qualifiers:	ND - Not Detected at the Reporting Limit	S - Spike Recovery outside accepted recovery limits
	J - Analyte detected below quantitation limits	R - RPD outside accepted recovery limits
	B - Analyte detected in the associated Method Blank	E - Value above quantitation range
	*	- Value exceeds Maximum Contaminant Level

Hall Environmental Analysis Laboratory

Date: 14-Oct-05

CLIENT: Daniel B. Stephens & Assoc.
Work Order: 0510090
Project: DBS & A

QC SUMMARY REPORT

Method Blank

Sample ID	MBLK	Batch ID:	R16957	Test Code:	Walkley Blac	Units:	% C	Analysis Date	10/13/2005	Prep Date		
Client ID:		Run ID:	WC_051013C	SeqNo:				SeqNo:	411132			
Analyte		Result:	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
FOC		ND	0.1									

Qualifiers:

ND - Not Detected at the Reporting Limit
J - Analyte detected below quantitation limits

S - Spike Recovery outside accepted recovery limits
R - RPD outside accepted recovery limits

B - Analyte detected in the associated Method Blank

J /
R /
B /

Hall Environmental Analysis Laboratory

Date: 14-Oct-05

CLIENT: Daniel B. Stephens & Assoc.
Work Order: 0510090
Project: DBS & A

QC SUMMARY REPORT
Laboratory Control Spike - generic

Sample ID	LCS	Batch ID:	R16957	Test Code:	Walkley Blac	Units: % C	Analysis Date	10/13/2005	Prep Date
Client ID:		Run ID:	WC_051013C				SeqNo:	411133	
Analyte		Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val
FOC		2.22	0.1	2.1	0	106	80	120	0

Qualifiers:

ND - Not Detected at the Reporting Limit
J - Analyte detected below quantitation limits

S - Spike Recovery outside accepted recovery limits
R - RPD outside accepted recovery limits

B - Analyte detected in the associated Method Blank

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Laboratory Tests and Methods



Daniel B. Stephens & Associates, Inc.

Tests and Methods

Dry Bulk Density: ASTM D4531; ASTM D6836

Moisture Content: ASTM D2216; ASTM D6836

Particle Size Analysis: ASTM D422

Fractional Organic Carbon*
Walkley Black

*Analysis performed by Hall Environmental Analysis Laboratory in Albuquerque, NM

Appendix E
Treatability Study Report

Rio Dell Texaco Treatability Study

Prepared for

SHN Consulting Engineers & Geologists, Inc.

by

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Two subsurface solids samples and one groundwater sample collected from the Rio Dell Texaco site by SHN Engineers & Geologists were evaluated for potential pilot- and full-scale treatment using activated persulfate (sodium persulfate and activators) and modified Fenton's reagent (hydrogen peroxide and iron catalysts). The two subsurface solids samples were composited by weighing 400 g of each into a large jar and then thoroughly mixing and shaking the composite sample. Treatment of the composite sample consisted of five general process conditions: 1) sodium persulfate activated by sodium hydroxide, 2) sodium persulfate activated by hydrogen peroxide, 3) hydrogen peroxide with pH adjustment to acidic pH, 4) hydrogen peroxide with pH adjustment to acidic pH and soluble iron (III) addition, and 5) hydrogen peroxide stabilized by phytate, citrate, and malonate. Additional data collection included persulfate and hydrogen peroxide decomposition rates and temperature changes in the systems.

Methodology**Sample Characterization**

The amount of water required to saturate the well cuttings was first determined by adding groundwater in 0.1 ml increments until the groundwater covered the solids; the volume of groundwater required to cover the solids was 2.8 ml/10 g of solids or 280 ml/kg of solids. Thereafter, treatability studies were conducted using 2.8 ml of groundwater/10 g of subsurface solids. The composited well cutting samples saturated with groundwater were then analyzed for pH by adding 10 ml of deionized

requirement for lowering the composited subsurface solid-groundwater was determined by adding varying quantities of 25% sulfuric acid (e.g., 0.03 ml, 0.04 ml, 0.05 ml through 0.10 ml) per 10 g of subsurface solids and 2.8 ml of groundwater and monitoring the pH over 48 hours. The sample addition that provided a pH of 3 after 48 hours was the acid addition used for subsequent oxidation studies. The acid requirement for adjusting the pH for the composited samples was 0.04 ml/10 g of solids.

Treatment Using Activated Persulfate

Persulfate is significantly more stable than hydrogen peroxide, and its activation is critical to effective treatment of the subsurface. Persulfate has the potential to persist in the subsurface for up to 500 days. The most effective routes of activation have been shown to be with base (e.g., sodium hydroxide) and hydrogen peroxide. Vials containing 10 g of subsurface solids and 2.8 ml of groundwater received three different concentrations of persulfate: 5%, 10%, and 20%. Sodium hydroxide was added to the persulfate in molar ratios of 1 mole persulfate: 2 moles of sodium hydroxide. Hydrogen peroxide was added to persulfate in molar ratios of 1 mole persulfate: 4 moles of hydrogen peroxide. Samples were collected at 10 days, three weeks, and 14 weeks. Residual persulfate was measured in the samples before they were extracted for hydrocarbon analysis.

Treatment Using Modified Fenton's Reagent

Modified Fenton's reagent is the catalyzed decomposition of hydrogen peroxide by various catalysts into hydroxyl radicals and other reactive oxygen species. Hydrogen peroxide has minimal potential for degrading organic contaminants; however, hydroxyl radicals react with most contaminants, such as gasoline, perchloroethylene, and polychlorinated biphenyls, at extremely fast rates. The most common catalysts employed include soluble iron, chelated iron, and naturally-occurring iron minerals found in the subsurface. Although modified Fenton's reagent is capable of degrading all organic contaminants, it is limited by its instability and short lifetime in the subsurface. However, recent findings from research conducted at WSU have shown that a few organic acids can significantly enhance the stability of hydrogen peroxide in the subsurface.

Treatability reactions were conducted using 10 g of well cuttings and 2.8 ml of groundwater in sealed 40 ml volatile organic analysis (VOA) vials. Hydrogen peroxide and the supplemental agent (e.g., acid, soluble iron, or stabilizer) were added to the vials at a volume of 2.8 ml (i.e., the equivalent

peroxide was consumed. The entire vial contents were then extracted with methylene chloride and analyzed for residual hydrocarbons by gas chromatography/flame ionization detection.

Analyses

Total petroleum hydrocarbon concentrations were quantified using a modified 8015 methodology on a Hewlett Packard 5890A gas chromatograph equipped with a flame ionization detector (FID) and a 50-m DB-1 capillary column. Chromatographic conditions included initial oven temperature of 100 °C, program rate of 10°C/min, final temperature of 240°C, injector temperature of 250°C, and detector temperature of 300°C. The sum of all of the peaks exclusive of methylene chloride was compared to results of a standard curve prepared from gasoline dissolved in methylene chloride. Hydrogen peroxide was measured by iodometric titration.

Results

Based on GC chromatograph areas, the majority of the hydrocarbons eluted below 180 °C, indicating a significant proportion of the hydrocarbons are gasoline or a similar volatile petroleum fraction. The results of treating the subsurface solids-groundwater with modified Fenton's reagent with acidification and soluble iron addition are listed in Table 1. The data indicate that the petroleum hydrocarbons were effectively destroyed with all concentrations of hydrogen peroxide at pH 3 with no iron addition and with $\geq 12\%$ hydrogen peroxide with iron amendment. Results of the treatment of the subsurface solids-groundwater with hydrogen peroxide stabilized by citrate, malonate, or phytate are listed in Table 2. The hydrocarbons were effectively treated with $\geq 9\%$ hydrogen peroxide using citrate as a stabilizer or 15% hydrogen peroxide using malonate and phytate as stabilizers. Results from the treatment of the subsurface solids-groundwater using activated persulfate are listed in Table 3. Base-activated persulfate was very effective in treating the hydrocarbons in the soil-groundwater slurries, with nondetectable concentrations achieved after 14 weeks. Furthermore, a substantial pool of persulfate remained in the slurries (shown in the fourth column of Table 3), which would provide the potential for the treatment of hydrocarbons in low permeability regions by allowing the residual persulfate the time to diffuse toward the sequestered contaminants. Hydrogen peroxide-activated persulfate was not as effective as base activated persulfate; furthermore, the persulfate was not as long lived when it was activated by hydrogen peroxide.

Table 1. Results of Fenton's treatability using hydrogen peroxide at pH 3 (with catalysis by the naturally-occurring minerals present), hydrogen peroxide and soluble iron at pH 3, and hydrogen peroxide and 1000 mg/L iron (III) sulfate.

Sample	TPH (mg/kg)	Percent Destruction
Control	234	
6% Hydrogen peroxide, no pH adjustment	151.4	35.5
9% Hydrogen peroxide, no pH adjustment	163.0	30.3
12% Hydrogen peroxide, no pH adjustment	141.1	39.7
15% Hydrogen peroxide, no pH adjustment	153.5	34.4
6% Hydrogen peroxide, pH 3	87.6	62.6
9% Hydrogen peroxide, pH 3	66.8	71.5
12% Hydrogen peroxide, pH 3	84.1	64.1
15% Hydrogen peroxide, pH 3	39.7	83.0
6% Hydrogen peroxide, pH 3, 1,000 mg/L ferric sulfate	107.8	53.9
9% Hydrogen peroxide, pH 3, 1,000 mg/L ferric sulfate	245.9	0
12% Hydrogen peroxide, pH 3, 1,000 mg/L ferric sulfate	30.8	86.8
15% Hydrogen peroxide, pH 3, 1,000 mg/L ferric sulfate	25.6	88.7

Table 2. Results of Fenton's treatability using hydrogen peroxide with no pH adjustment (with catalysis by the naturally-occurring minerals present) and stabilization by three different organic acids.

Sample	TPH (mg/kg)	Percent Destruction
Control	234	
6% Hydrogen peroxide, 2,000 mg/L citrate	188.4	19.5
9% Hydrogen peroxide, 2,000 mg/L citrate	106.8	54.4
12% Hydrogen peroxide, 2,000 mg/L citrate	81.9	65.0
15% Hydrogen peroxide, 2,000 mg/L citrate	73.0	68.8
6% Hydrogen peroxide, 2,000 mg/L malonate	160.0	31.6
9% Hydrogen peroxide, 2,000 mg/L malonate	114.1	51.2
12% Hydrogen peroxide, 2,000 mg/L malonate	220	6.0
15% Hydrogen peroxide, 2,000 mg/L malonate	41.1	82.4
6% Hydrogen peroxide, 2,000 mg/L phytate	684	0
9% Hydrogen peroxide, 2,000 mg/L phytate	232.7	0.6
12% Hydrogen peroxide, 2,000 mg/L phytate	90.0	61.5
15% Hydrogen peroxide, 2,000 mg/L phytate	39.7	83.0

Table 3. Results of activated persulfate treatability with activation by hydrogen peroxide or sodium hydroxide

Sample	TPH (mg/kg)	Percent Destruction	Persulfate Residual (%)
<i>t=10 days</i>			
Control	216		
5% Sodium persulfate, Sodium hydroxide	169.5	21.5	1.4
10% Sodium persulfate, Sodium hydroxide	84.9	60.7	2.1
20% Sodium persulfate, Sodium hydroxide	34.1	84.2	7.1
5% Sodium persulfate , Hydrogen peroxide	160	25.9	1.5
10% Sodium persulfate , Hydrogen peroxide	187.0	13.4	1.7
20% Sodium persulfate , Hydrogen peroxide	330.3	0	N.D.
<i>t=3 weeks</i>			
Control	188		
5% Sodium persulfate, Sodium hydroxide	121	35.6	1.2
10% Sodium persulfate, Sodium hydroxide	82	56.4	2.9
20% Sodium persulfate, Sodium hydroxide	26	86.2	5.7
5% Sodium persulfate , Hydrogen peroxide	153	18.6	N.D.
10% Sodium persulfate , Hydrogen peroxide	89	52.7	N.D.
20% Sodium persulfate , Hydrogen peroxide	53	71.8	N.D.
<i>t=14 weeks</i>			
Control	142		
5% Sodium persulfate, Sodium hydroxide	N.D.	>99.9	0.71
10% Sodium persulfate, Sodium hydroxide	N.D.	>99.9	2.0
20% Sodium persulfate, Sodium hydroxide	N.D.	>99.9	3.8
5% Sodium persulfate , Hydrogen peroxide	112	21.1	N.D.
10% Sodium persulfate , Hydrogen peroxide	69	51.4	N.D.
20% Sodium persulfate , Hydrogen peroxide	12	91.5	N.D.

Hydrogen peroxide residuals as a function of time for the conditions that provided effective hydrocarbon treatment are listed in Tables 4, 5, 6, and 7. Hydrogen peroxide residuals for the acidified samples that showed effective hydrocarbon treatment are listed in Table 4. Hydrogen peroxide residuals for slurries stabilized by citrate, malonate, and phytate are listed in Tables 5, 6, and 7, respectively. The data indicate that hydrogen peroxide is very unstable in the presence of these subsurface solids, even when the hydrogen peroxide stabilizing agents were added; i.e., the maximum

lifetime was usually less than one day. Such instability of hydrogen peroxide negates its potential for use at the Rio Dell Texaco site.

Table 4. Hydrogen peroxide decomposition in treatments with acidification

Time	Hydrogen Peroxide (%)			
	12% H ₂ O ₂ , pH 3	12% H ₂ O ₂ , pH 3, 1,000 mg/L ferric sulfate	15% H ₂ O ₂ , pH 3,	15% H ₂ O ₂ , pH 3, 2,000 mg/L ferric sulfate
0	12.2	12.0	14.9	14.9
4 hr	6.8	8.1	8.9	9.7
8 hr	2.5	4.1	4.7	5.9
1 days	N.D.	N.D.	N.D.	0.7
2 days	N.D.	N.D.	N.D.	N.D.
3 days	N.D.	N.D.	N.D.	N.D.
4 days	N.D.	N.D.	N.D.	N.D.
5 days	N.D.	N.D.	N.D.	N.D.
Maximum temperature (°C)	41	44	50	54

Table 5. Hydrogen peroxide decomposition in treatments stabilized by sodium citrate

Time	Hydrogen Peroxide (%)			
	12% H ₂ O ₂ , 100 mg/L citrate	12% H ₂ O ₂ , 500 mg/L citrate	15% H ₂ O ₂ , 1,000 mg/L citrate	15% H ₂ O ₂ , 2,000 mg/L citrate
0	12.1	12.1	14.8	14.9
4 hr	4.8	5.1	7.9	9.7
8 hr	2.7	3.0	4.5	5.9
1 day	N.D.	N.D.	N.D.	0.4
2 days	N.D.	N.D.	N.D.	N.D.
3 days	N.D.	N.D.	N.D.	N.D.
4 days	N.D.	N.D.	N.D.	N.D.
5 days	N.D.	N.D.	N.D.	N.D.
Maximum temperature (°C)	88	88	74	63

Table 6. Hydrogen peroxide decomposition in treatments stabilized by sodium malonate

Time	Hydrogen Peroxide (%)			
	12% H ₂ O ₂ , 100 mg/L malonate	12% H ₂ O ₂ , 500 mg/L malonate	15% H ₂ O ₂ , 1,000 mg/L malonate	15% H ₂ O ₂ , 2,000 mg/L malonate
0	12.1	12.0	14.8	14.9
4 hr	5.5	7.1	8.9	8.7
8 hr	1.5	2.7	3.8	4.9
1 day	N.D.	N.D.	N.D.	N.D.
2 days	N.D.	N.D.	N.D.	N.D.
3 days	N.D.	N.D.	N.D.	N.D.
4 days	N.D.	N.D.	N.D.	N.D.
5 days	N.D.	N.D.	N.D.	N.D.
Maximum temperature (°C)	61	54	46	41

Table 7. Hydrogen peroxide decomposition in treatments stabilized by sodium phytate

Time	Hydrogen Peroxide (%)			
	12% H ₂ O ₂ , 100 mg/L phytate	12% H ₂ O ₂ , 500 mg/L phytate	15% H ₂ O ₂ , 1,000 mg/L phytate	15% H ₂ O ₂ , 2,000 mg/L phytate
0	12.3	12.1	14.9	14.9
4 hr	7.8	8.1	8.9	10.7
8 hr	4.5	5.1	4.8	6.9
1 day	N.D.	N.D.	N.D.	0.5
2 days	N.D.	N.D.	N.D.	N.D.
3 days	N.D.	N.D.	N.D.	N.D.
4 days	N.D.	N.D.	N.D.	N.D.
5 days	N.D.	N.D.	N.D.	N.D.
Maximum temperature (°C)	52	44	37	34

Maximum temperature increases following reagent addition for Fenton's systems are also included in Tables 4 through 7. These data show that temperature increases were very high in all of the Fenton's systems. These results are complementary to the hydrogen peroxide decomposition data; higher temperatures promote the rapid decomposition of hydrogen peroxide, resulting a low degree of hydrogen peroxide stability and minimal potential for transport downgradient.

RECOMMENDATION

Based on laboratory treatability studies, the application of modified Fenton's reagent using all concentrations of hydrogen peroxide at pH 3 or >12% hydrogen peroxide with the addition of stabilizers at neutral pH provides effective destruction of hydrocarbons at the Rio Dell site; however, hydrogen peroxide is highly unstable in this soil-groundwater system, and the use of modified Fenton's reagent for hydrocarbon destruction is not recommended. Base-activated persulfate promoted hydrocarbon destruction to undetectable levels; furthermore, base-activated persulfate is highly stable in this subsurface system, providing the potential for its diffusion and hydrocarbon destruction into regions of low permeability.